

T H E S I S

o n

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EPIDEMIC DIARRHOEA OF INFANTS.

INTRODUCTION.

Great advances have been made in medicine within the past 25 or 30 years; indeed, the discovery in the sciences of physiology, pathology, and bacteriology have placed medicine amongst the exact sciences: at any rate, the investigations of bacteriologists and pharmacologists have placed at our disposal many agents which have proved of wonderful service in the hands of skilful physicians.

But if we wish to learn the result of the scientific study of disease, we must turn to the question of preventive medicine. The axiom that "an ounce of prevention is better than a pound of cure" has proved itself true with regard to medicine. Preventive medicine, or hygiene, aims at the prevention of disease in general, whereas curative medicine only applies to the individual.

It is only within the last 15 or 20 years that preventive medicine has begun to receive that careful study which its object deserves; since then, however, wonderful progress has been made, as shown, for instance, by the diminished death-rate from nearly all classes of diseases, - the two exceptions being malignant diseases and infantile affections. The death-rate from the former has steadily increased year by year, whilst the infantile mortality has shown no perceptible decline, and in many places it has actually increased within the last 30 years. This, too, in spite of our boasted civilisation and practical achievements in medical science and hygiene.

The general death-rate from all causes has shown a decline of 20 per cent., while the infantile mortality from all causes per 1000 births has remained practically the same during the last 40 years.

Such a condition of things must surely give us cause for alarm, especially when we are faced by a steady decline in the birth-rate of this country. It is the same problem which has been exercising the attention of the French government for the last 15 years; and, unless our own government deems it advisable to give the matter due attention, I am

afraid we will not only be stigmatised as a degenerate population, but be compelled to deal still more with the all-important problem of depopulation.

It cannot be expected that the medical profession can do more than point out to the government the dangers ahead, in the hope that the latter will, as loyal citizens, awaken to their duty, and co-operate with the profession in this country in an earnest and persevering endeavour to stem the tide of our ever-increasing infantile mortality. With our vast colonial possessions it behoves us, as a nation, to seriously deal with this question. If we intend to go on colonising in future as we have done in the past: then let the State provide for the education of the girls at school in the duties of motherhood. On the lines adopted in France, moreover, municipal authorities throughout the country might be encouraged to provide pure, wholesome milk for their infantile population. Furthermore, a skilled staff of trained nurses ought to be provided to visit each home where a birth has occurred, and instruct the mother in the care of her offspring.

When we come to inquire into the cause of this high death-rate in infants, we find that ignorance, improper food or careless feeding, unhealthy surroundings, drunkenness, vice, and the employment of female labour, contribute mainly thereto. Under such circumstances, and owing to the tendency of the population of this country to gravitate towards the towns, it is not to be wondered at that the chief cause of the high death-rate among the infantile population lies in the occurrence of catarrhal or inflammatory disease of the alimentary canal; which, for want of a better name, is often spoken of as "diarrhœa"; but the particular form of this affection, and that upon which I am about to dissertate, is "epidemic diarrhœa".

The malady in question usually occurs during the summer months, - in the form of an epidemic, confined chiefly to infants under 2 years of age. It is characterised, moreover, by vomiting, diarrhœa, and general toxæmia - the result of bacterial changes in the food, either before or after the micro-organismal somatic invasion.

In England and Wales, during the last 25 years, epidemic diarrhœa of infants has been responsible for about 7.5 deaths, under five years of age, per 1000 living at that age; and in some places it has been as high as 25 deaths per every 1000 living under 3 years. From the returns of the Registrar-General, we find that 85 per cent. of the deaths

from epidemic diarrhœa occur in infants under 2 years of age; this gives a death-rate of from 5 to 10 deaths, from epidemic diarrhœa alone, for every child under 2 years of age.

Measles and whooping-cough, the other two great scourges of infancy in this country, are together only responsible for about the same number of deaths at that age. The remaining six zymotic diseases of the Registrar-General, when combined, only contribute a little over 10 deaths per 1000 living under 2 years.

Facts like these should serve to convince even the most sceptical of the great truth that epidemic diarrhœa is one of the most potent causes of the high death-rate amongst the infantile population of this country; and that anything which will tend to a reduction of this mortality will, to a large extent, solve the very complex problem of death in infancy, and so remove one of the darkest blots in our book of national progress.

S Y N O N Y M S.

Diarrhœa epidemica (Latin); Diarrhée epidémique (French); Epidemisch Diarrhoe (German); Epidemic diarrhœa; Zymotic enteritis; Summer diarrhœa; April and May disease (American writers); Cholera infantum; Epidemic enteritis; Gastro-enteritis; and many other names which have from time to time been employed, with more or less accuracy, to designate this affection.

N O M E N C L A T U R E.

The malady is now included under the head of zymotic diseases, by order of the Registrar-General. Quite recently, too, the Royal College of Physicians of London have authorised the use of the terms epidemic enteritis and zymotic enteritis, to include all gastro-intestinal diseases of children, that is to say, when the affection in question is accompanied by vomiting and diarrhœa, and tends to occur during the summer months in an epidemic form amongst young children.

It is rather a pity that the term diarrhœa has come to be employed for this disease, as it has led to much ambiguity in the classification of death returns. Diarrhœa is not a disease: it is only a symptom of what may be a perfectly

physiological process, or, on the other hand, it may signify the presence of any one of more of a large number of diseases.

For the sake of comparative statistics, it is to be hoped that in future years the efforts now put forth for a more uniform classification, may result in the general adoption of the terms authorised by the Royal College of Physicians of London. As it is, a great difficulty exists in determining the proportion of deaths returned as due to various catarrhal and inflammatory conditions of the alimentary canal. Such loose terms as "bowel complaint", "gastro-enteric catarrh", and "colitis", which frequently figure in the certificates of death, should be abandoned, and a more exact terminology wherever possible adopted.

D E F I N I T I O N .

The word diarrhoea, when literally interpreted, merely denotes an abnormally fluid state of the evacuations from the bowels. The contents of the small intestines during health are always of a semi-fluid consistency; in passing into the caecum a large portion of this fluid becomes absorbed; so that the semi-solid residue is moulded into cylindrical masses by the contractile and peristaltic action of the colon and rectum before leaving the body. Sometimes, when the contents are allowed to remain for a long time in the large intestine, as occurs in constipation, the dejecta become hard and dry, all the watery portion having been absorbed into the system. On the other hand, should the intestinal contents be hurried along too quickly, by increased peristaltic activity, or should the lining membrane of the bowel, from any cause, fail to absorb the fluid portion of its contents, or instead of absorbing fluid, should increased secretion of intestinal juices and fluid take place, - then the stools, instead of being semi-solid, leave the body in a fluid state.

Increased peristaltic action may be set up also by a large number of drugs. Anything which tends to irritate the lining membrane of the bowel will not only increase the peristaltic activity of the intestines, but will lead to the pouring out of secretions into the lumen of the bowels.

Conditions which give rise to irritation of the mucous membrane of the stomach or small intestines are necessarily followed by diarrhoea, unless the absorbent powers of the

large intestines are ^{increased} ~~in abeyance~~, or their peristaltic action ~~increased~~ ^{increased} ~~in abeyance~~.

In epidemic diarrhœa, the combination of circumstances which result in diarrhœa, is to be found in the increased peristaltic action of the whole intestinal tract, together with an increased pouring out of fluids by the mucous membrane of the small intestines, and the failure of the large intestine to absorb the fluid portion of their contents. This failure of the large intestine to perform its physiological function may result, either from the rapidity with which its contents are hurried along, or from the presence of existing catarrhal or inflammatory changes in its mucous membrane.

Many articles of diet, as well as drugs, are capable of irritating the mucous membrane of the stomach and bowels, and so of bringing about diarrhœa. Food may act by, either directly irritating the mucous membrane of the alimentary canal, or by the occurrence of chemical or biological changes in the food, before or after it has entered the stomach; and, as a result of these changes, poisonous agents are produced, which, on being absorbed into the system, give rise to inflammation of the stomach and intestines. Frequently diarrhœa results without any inflammation, these poisonous agents acting on the nervous mechanism of the stomach and bowels, causing paralysis of the vaso-motor nerves and increased transudation of fluids into the lumen of the bowel.

Several varieties of bacteria possess a specific power of causing diarrhœa in the intestines where they occur. Thus, the cholera vibrio, the bacillus typhosus, and many varieties of the colon bacillus, appear to produce diarrhœa, by either setting up inflammatory or catarrhal changes in the mucous membrane of the intestines, or by the toxins which result from their activity. Furthermore, many act through the nerves of the intestines in the manner already explained.

This effort of the system to rid itself of poisonous agents, is also seen in the diarrhœa associated with uræmia, pneumonia, scarlatina, measles, malaria, and a number of other febrile affections, characterised by the presence of toxins in the blood.

E A R L Y H I S T O R Y.

This appears to be shrouded in considerable obscurity, owing to the absence of any attempt at uniformity in the descriptive classification of the disease by the earlier writers on the subject.

Diseases of childhood have, in the past, been too frequently described under the headings of their most prominent symptoms; and, as the symptoms of any given disease are very prone to change their characters in different outbreaks of the same disease, and under different circumstances also, it is not uncommon to find the disease referred to by the earliest authors under different names.

Benjamin Rush appears to have been the first to call special attention to this disease in America, in the year 1773. Its occurrence during the summer months led this author to speak of it as the "summer complaint". Other American writers, of the same period, speak of it under the name of "April and May disease", the "disease of the seasons", etc.

In this country, the first to make special mention of the malady now under discussion was W. Heberden, Junr., who calls it "gripping in the guts". The London Bills of Health during the 17th and 18th centuries, when examined, reveal a very high death-rate from this disease.

Towards the beginning of the 18th century, owing to the association of convulsions with very many of the cases of diarrhœa, there occurred a gradual diminution in the number of deaths returned under the term "gripping in the guts", and also a proportionate increase in the number of deaths from convulsions; but, from what we know now of the clinical manifestations of epidemic diarrhœa, we can well understand this change in the nomenclature, when its classification depended upon the predominance of some one symptom. Owing to the age at death not being stated in the death returns until the year 1827, it is difficult to tell how many of the deaths as due to "convulsions" occurred in young children. But the return of the year 1827 does show that practically the half of the infants dying during the summer months, under two years of age, were recorded as having died from "convulsions", and very few from "gripping in the guts". By this time, moreover, the latter term appears to have to a very great extent

given place to the former.

Any evidence as to the relative incidence of these two diseases, amongst children prior to the year 1827, must be gathered from the writings of authors on this subject. From these we are, I believe, justified in concluding that both "griping in the guts" of the 17th century, and "convulsions" of the 18th, were one and the same disease - viz., that which we now call "epidemic diarrhœa"; and, further, that then, as now, the chief incidence of the disease was amongst infants under 2 years of age. The number of deaths from "convulsions", prior to 1827, is found to be practically the same as those returned as resulting from this disease during the later years, in children under 5 years of age. This shows, I think, that "convulsions" may be regarded as practically a disease of infancy; and, if this be proved, it is my conviction that the condition referred to as "griping of the guts" must also have been a disease of infancy, - for we have already seen that the two terms ~~referred~~ referred to one and the same morbid condition.

Sydenham, writing of "griping in the guts", in the year 1669, says that: "it was a disease **which** attracted, chiefly the **young** of hot and bilious temperament, and was more rife in the hot summer". No doubt this remark was called forth by the exceptionally high mortality in London during the very hot summer of 1669. For the 11 weeks ending October 26th, 1669, no fewer than 3465 deaths were returned as due to "griping in the guts", whereas the total number of deaths from all causes in London was only 7967.

A little later, we find Willis speaking of convulsions in these terms: "They occur at two special periods of life - within a month of birth and during teething" As regards the cause, he says: "Distemper seems to be in the viscera, either worms or sharp humours stirring up to torment of the belly, are understood to be at fault".

That this disease occurred in epidemics during the warm summer and autumn months, the observation of Sydenham, already quoted, prove; and further proof is to be obtained from a perusal of the weekly bills of health of the London Parish Clerks, during the 17th and 18th centuries.

Dr. Walter Harris, in the year 1689, says that "from the middle of July to the middle of September these epidemic gripes of infants are so common (being the annual heat of the season doth entirely exhaust their strength) that

more infants affected with these do die in one month, than the other three that are gentle". That this was a very fatal disease, and contributed more than any other to the high general death-rate of the 17th and 18th centuries, is evident from a study of the Bills of Health for the different districts of London, sometimes reaching as high as 40 per cent. of the total deaths from all causes; and, in 1723, it even reached a still higher figure. Strother, writing in the summer of 1828, on the high mortality amongst children says: "There was much diarrhœa in London last autumn and this summer, the effects of which, upon the bills of mortality, are nowhere visible except under the enormous weekly totals of convulsions". This proves conclusively that convulsions was the name used in certifying nearly all the deaths from diarrhœa, and that the two terms are identical.

It would appear, from the study of the early history of the disease, that it has a peculiar tendency to occur every 3 to 5 years with increased virulence, and ~~that this~~ ^{appears} also characteristic of the disease under its new name of epidemic diarrhœa.

It appears that convulsions was a kind of generic term, which was used to include not only epidemic diarrhœa and similar conditions of the gastro-intestinal tract, but almost every other disease of infancy. Thus, in the death returns for London during the autumn of 1734, over 80 per cent. of all deaths under 2 years are included under the head of convulsions, which, here again, furnished a little less than 40 per cent. of the total deaths from all causes for every age.

As throwing some sidelight on the cause of the high death-rate amongst children in London during the 18th century, I now quote from an article written by Dr. W. Fordyce, and published in London in 1773, in which he says: "I speak within the bounds of truth when, judging from the bills of mortality and the number in such circumstances, who have been brought to my door since the year 1750, I assert there must be very nearly 20,000 children in London and Westminster, and the suburbs ill at the moment of the hectic fever, attended by ~~two~~ bellies, swollen wrists and ankles or crooked limbs, owing to the impure air which they breathe, the impure food on which they live, or the improper manner in which their parents or nurses rear them up for they live in hot beds of chambers, or nurseries, they are fed even on meat before they have got their teeth, and what is if possible

still worse, on biscuits not fermented, on buttered rolls, on calves' feet, jellies, on strong broth, yet more calculated to load all their powers of digestion, or are totally rejected". This shows that much the same conditions, as we now associate with the prevalence of epidemic diarrhoea, existed in London during the eighteenth century, when the infantile mortality under two years of age constituted such a high percentage of the deaths.

Hirsch says: "There can be no doubt that this malady had occurred at all times under the circumstances that give rise to it now, and that it has become commoner just in proportion as the etiological factors have made themselves felt in a more intense form and over a wider area".

The early evidence pertaining to the prevalence of this disease in the provincial and other parts of the United Kingdom, is not forthcoming. The disease is one essentially associated with the aggregation of the population into towns; and, as most of the population of all parts of the United Kingdom, except London, during the 16th and 17th centuries, were essentially rural, the absence of any severe epidemic of the disease outside the capital is explained. But with the increase of industrial enterprise, and the consequent flocking of the rural inhabitants towards these industrial centres, other large towns began to spring up all over the kingdom; and we find the same class of circumstances existing in such cities as Manchester, Liverpool, Edinburgh, Glasgow, Newcastle-upon-Tyne, Dublin, etc., during the latter half of the 18th century, as characterised London in the two preceding centuries.

Under the name of "bowel hive", we find that the malady was responsible for 6 or 7 per cent. of all deaths in Edinburgh and Glasgow towards the close of the 18th century. Several of the above-mentioned cities exceed in population that of London during the 16th and 17th centuries: the result of this has been to maintain the high infantile mortality from all causes, more especially that due to diarrhoea.

G E O G R A P H I C A L D I S T R I B U T I O N .

Hirsch states that "the disease occurs all over the globe," and that "it is worst when the casual conditions are most felt." Indeed, no part of the world has been exempt from this malady; for it is a disease which has followed the march of civilisation, and its chief incidence has been amongst the inhabitants of large cities and towns.

Northern latitudes have been particularly free from any serious or prolonged outbreak, whilst tropical and temperate zones have suffered severely. Very early in the history of the North American Continent, the disease made its appearance, and each summer killed large numbers of the children in all the large towns. In 1829, Horner spoke of it as "a disease entirely American; and Grant, a few years later, writing of the high death-rate from cholera infantum at Memphis, alludes to that town as "the graveyard of children". In Boston, Massachusetts, and Michigan during the middle of the 19th century, it caused no less than from 15 to 20 per cent. of the total deaths from all causes. King says: "More children die of cholera infantum and lobular pneumonia than from all other diseases in America".

No mention is made of the occurrence of the disease in Central or South America, or on the Continent of Asia: possibly the backward state of medical education in these countries is responsible for this absence of information. Ruz, in 1869, stated that it was very prevalent at Martinique; and, according to available statistics, it was the chief cause of death in the first year of childhood.

The disease does not appear to have received special note, so far as the Continent of Europe is concerned, until within recent date; but there can be no doubt, so far at least as the southern portion of Europe is concerned, that the disease was very prevalent in many of the large cities, and was the cause of much morbidity and mortality amongst children. But the evidence of this is entirely founded on the very high death-rate amongst infants, from all causes, during the 17th and 18th centuries;— the chief cause of which, as we

have already seen in the case of this country, was the prevalence of diarrhœa.

Towards the close of the 19th century, the disease began to receive more attention, owing to the large number of infants dying from it during the summer months. We find that in Berlin, during the 5 years 1877-1882, it caused 17,645 deaths alone, which was about 2.6 per 1000 of the population of that city. The same obtains also in the case of France and Italy.

Owing to the absence of uniformity in mortality classifications, it is extremely difficult to trace the disease back to the writings of the physicians of the 17th and 18th centuries. At any rate, epidemic diarrhœa possesses none of the classical dignity attached to such diseases of antiquity as plague, small-pox, etc.; and, were it not for the attention given to this subject by such men as Rush, in America, and Heberden, in this country, our knowledge of the early prevalence of the affection would be practically nil.

The only mention of the occurrence of the disease in Africa is contained in a reference to its very common prevalence at Port Said - by Vanvray in 1873. Both Hall and Richardson refer to the high death-rate from this disease in the Australian colonies about the same date.

Reference has already been made to the large number of deaths from this disease in Berlin during the years 1877 - 1882. The same, indeed, may be said for all the other large cities of Germany at this period. According to the health statistics of Würnberg for 1863, it reached the high figure of 2.9 per thousand of the population, from all causes. Depp tells of its occurrence in St. Petersburg, and in the other cities of Russia.

Mention has also been already made to the early presence of the disease in London, Edinburgh, and other cities in this country. Hill, in 1876, writing to the Medical Times and Gazette, attributes to it a death-rate of 2.04 per 1000 living.

CLASSIFICATION.

Our present uncertainty as to the true etiology of this disease renders any attempt at classification somewhat difficult, more especially as, under its comprehensive designation, we are dealing with more than one disease. For the purpose of death registration, however, it has been decided to include under the name of epidemic enteritis those conditions in infants, which give rise to vomiting and diarrhœa during the summer and autumn months, and which more or less partake of the general features of an epidemic.

As our knowledge of this group of disorders increases, we may venture to hope that we shall in due time be able to arrive at some reliable and scientific classification of the disease under consideration, just as we have done in the case of the specific fevers. The investigations of the bacteriologists have done much to clear up the confusion which hitherto existed respecting the nature of many formerly obscure conditions, and so enabled a scientific classification to be arrived at. Up to now, however, the results, so far as epidemic diarrhœa is concerned, have not been attended with such success as to justify any classification under this head possible.

The classification adopted by the majority of the American authors who have given special attention to the subject, whilst open to some criticism, is, on the whole, the most comprehensive. This classification is based on the pathological manifestation and the clinical features of the disease, and allows of the division of the disease into: (1) non-inflammatory and (2) inflammatory diarrhœa. The first group comprises a large number of gastro-intestinal conditions accompanied with a rise of temperature, profuse diarrhœa, and vomiting, as well as loss of appetite, thirst, profound nervous disturbances, collapse, small and rapid pulse, irregular and shallow breathing, rapid loss of weight, and diminution or suppression of urine, which we see designated "cholera infantum", or "mycotic diarrhœa", by most American authors.

Escherich also divides epidemic diarrhœa into two groups: (1) those cases whose source of infection lies outside the body (ectogenous); and (2) those in which the cause of infection is pre-existent in the system (endogenous).

Such an arrangement, whilst not very useful for purposes of description, is nevertheless in keeping with the latest discoveries into the etiological ^{factors} ~~sphere~~ of the disease. In the first group he includes those forms of diarrhœa of toxic origin, - such as the cholera infantum and the mycotic diarrhœa of the American authors, - and in the second group he includes the diarrhœas which are caused by the several varieties of bacteria already present in the bowel, and which, according to Booker, may under favourable circumstances increase to enormous numbers, and become at the same time very virulent.

For our present purpose, however, it is more convenient to include under the term epidemic enteritis, all toxic diarrhœas of bacterial origin, - whether the result of germs already present in the bowels or of those ingested with the food and drink. This group would include such fermentative diarrhœas as cholera infantum, epidemic summer diarrhœa, and most of the acute inflammatory diarrhœas. The sub-acute and chronic diarrhœas of infants, although differing in their morbid anatomy and clinical manifestations from the acute forms, are nevertheless in most cases dependent upon the occurrence of an attack of the latter, and are not of distinct etiological significance. We have, therefore, the following forms:

- I. Acute Dyspeptic Diarrhœa.
- II. Acute Inflammatory, or Fermentative Diarrhœa - of toxic or bacterial origin.
- III. Chronic Diarrhœa - including a large number of the diarrhœas in children, which mostly have their origin in one or other of those forms comprised in the foregoing groups.

I. ACUTE DYSPEPTIC DIARRHOEA.

ETIOLOGY

Were it not for the fact that this condition is very frequently the predecessor of the more serious affection embraced under the heading of inflammatory or toxic diarrhœa, reference to it would here be unnecessary and supererogatory. In connection with this category I purpose referring only very briefly to those conditions which may, in the case of

infants, result in slight disturbance of the digestive functions, and end in diarrhœa.

There can be very little doubt that the chief factor in the production of dyspepsia in infants is improper or irregular feeding, especially in the case of hand-fed infants. The other predisposing causes are overcrowding in large towns, absence of ventilation and sunlight, damp, filthy habitations, ignorance, vice, and intemperance.

It is a deplorable fact that so many mothers are either unable or unwilling to nurse their infants, thus depriving them of the nourishment which nature intended for their sustenance during the first months of life, - this necessitating the employment of hand-feeding and all the risks contingent thereto.

Overfeeding is responsible for more disorders of infantile digestion than perhaps any other condition associated with the hand-feeding of infants. In both cases the results are the same. A portion of the food may undergo digestion and assimilation, but the remainder acts as a foreign body in the stomach and intestines, and stimulating peristalsis, with the outpouring of an increased quantity of mucus and intestinal secretion into the lumen of the bowels. Furthermore, if the undigested food is not quickly got rid of, fermentative changes are apt to occur in it, with the production of various toxic alkaloids, acids, and gases, - these acting on the mucous membrane of the stomach and intestines inducing inflammation, as well as the condition typically exemplified by epidemic enteritis, or mycotic diarrhœa.

It is especially in infants fed on a diet rich in farinaceous and saccharine substances, that this fermentation is most apt to occur; but food too rich in proteids may also, owing to the difficulty with which they are digested, give rise to inflammatory conditions of the bowels. Infants, whose digestive organs have been weakened by previous illnesses, are more likely to be attacked than healthy children.

Exposure to cold in some cases may determine the onset of the disease, especially in rickety infants. High atmospheric temperature is a powerful factor, probably acting through the nervous system and interfering with the digestion.

The affection also accompanies other fevers or nervous disorders, such as measles, whooping-cough, diphtheria, and small-pox, and such disturbances of the nervous system as

fright, dentition, etc.

All these factors will be more fully dealt with when we come to treat of inflammatory diarrhœa and its etiological relationship to dyspepsia in infants.

PATHOLOGY AND MORBID ANATOMY.

It is a very rare thing for this disease to prove fatal until other morbid changes have set in which entirely mask the original condition. I have only seen two cases where death resulted from dyspeptic diarrhœa. In one of them, the autopsy was performed 5 hours after death, and in the other one within 14 hours. Although both infants showed all the usual symptoms of severe dyspepsia accompanied by diarrhœa and vomiting, - strange to say, the necropsy revealed scarcely any alteration in the condition of the mucous membrane of the stomach or intestines: at any rate, the clinical phenomena manifested during life were altogether out of proportion to the meagre morbid changes found after death. No trace of inflammation was found in the whole of the alimentary canal in either of the two cases; the contents of the bowels were of a greenish or dark green colour, very offensive, and mixed with mucus; masses of undigested fats were found in both the small and large intestines. The peritoneum and mesenteric glands were, for the most part, quite normal; some slight hyperæmia was noticed near the pyloric end of the stomach in one case. The large intestines, especially the cæcum and transverse colon, presented the appearance of slight catarrhal changes in the mucous membrane. Peyer's patches and the solitary glands were, in one case, somewhat prominent in one or two areas, and a small hæmorrhage was seen in the submucous coat of the rectum in the other, - possibly due to straining.

Billard says: "Many children at the breast have diarrhœa without enteritis; they lose colour and weight, and fall into a state of marasmus, and yet at the autopsies not a trace of inflammation of the intestines is found!"

Rilliet and Barthez, after a comparison of the autopsies on over 300 infants, conclude that, quite frequently, and especially in early infancy, and also in cases in which the symptoms have pointed to some disease of the gastro-intestinal tube, "the autopsies reveal no lesions of the solids or only a change of minimum importance. The secretions alone are vitiated".

Emmet Holt also entertains similar views ~~similar views~~ with regard to the cases which he has examined in America.

Carefully conducted microscopical examinations of the bowels might, if effected immediately after death and before post-mortem changes have had time to set in, reveal some fine lesions, either in the mucous or submucous coats of the stomach or bowels. The selection of such suitable cases is somewhat difficult, as most of the cases of the disease reaching the post-mortem table are already the subject of other affections.

SYMPTOMS.

These are, briefly, general nervous disturbances, irritability, restlessness, sudden fits of screaming, - especially at night, - sleeplessness, pallor of the face. There may also be slight acceleration of the pulse-rate; fever is usually absent; the tongue is moist and slightly coated; the breath is sour and of a sickly odour; the appetite is usually diminished or capricious; thirst is sometimes present; and the urine is diminished in quantity, and of a high colour. The stools are more abundant, thinner, and of an acid reaction, and they consist of a residue of undigested food mixed with mucus and epithelial cells. The number of stools in the twenty-four hours is subject to great variation, but the evacuations are usually more frequent during the day than during the night. The abdomen is never painful to the touch, and it is seldom distended.

The child loses weight in proportion to the severity of the symptoms; pallor of the face becomes more marked; the eyes are sunken, and the face pinched; the muscles of the body lose their tone; the skin is dry and pale; vomiting and diarrhœa increase; and, if the case is left alone, it rapidly passes into the inflammatory type of the disease. This transition is usually accomplished within a week from the first evidence of the simpler disorder; but, if attention be directed towards correcting the diet, taking the child out into the fresh air, and rules laid down as to its surroundings and personal hygiene, the infant very quickly recovers, unless, of course, the disease has passed beyond the stage of simple dyspeptic diarrhœa.

PROGNOSIS.

Provided the case be seen early and taken to the country

forthwith, the outlook is usually favourable; but many of the cases are prone to relapses, which same, being very apt to terminate, especially during the warm weather, in the inflammatory type of the disease, must be specially guarded against.

DIAGNOSIS AND TREATMENT.

These subjects will be included under the heading of inflammatory diarrhœa, for they are practically the same in both cases.

II. INFLAMMATORY DIARRHOEA.

The above is rather a comprehensive designation, for it includes such conditions as entero-colitis, ileocolitis, zymotic enteritis, follicular enteritis, cholera infantum, and epidemic enteritis.

DEFINITION.

The particular variety of diarrhœa which I am about to describe occurs, in epidemic form, amongst infants under 3 years of age, especially in the hot summer months or in the autumn; and it is characterised by severe vomiting and diarrhœa, accompanied by fever and thirst. Some look upon it as a contagious disease, the specific cause of which is transmitted through milk, or by the agency of flies: anyhow, the disease is one that is responsible for a large number of deaths in children every summer, both in this country and America.

The chief incidence of the disease, at least so far as this country is concerned, falls on the hand-fed infants in the large manufacturing towns of Lancashire and Yorkshire, where there is so much employment for female workers.

In contradistinction to simple dyspeptic diarrhœa, inflammatory diarrhœa is characterised by definite constitutional disturbances; the stools, moreover, are more numerous and contain more mucus and sanguineous fluid - evidences of active changes in the intestinal mucous membrane.

FREQUENCY.

Reference has already been made to the heavy mortality caused by this disease in various parts of the globe. I believe, indeed, that there is no disease of infancy with which

we are acquainted that claims so many victims each summer as epidemic enteritis.

Although this affection is one which is only prevalent for about four months in each year, yet it is responsible for a higher annual death-rate amongst infants under 2 years of age than either measles or whooping-cough, which, next to diarrhoea, cause the largest mortality amongst infants. But, whereas a reduction in the number of deaths from these two diseases has taken place during the last 30 years, as a result of improvements in the sanitary surroundings of the people, the same cannot, however, be said regarding diarrhoea; for it is probably higher today for the whole of this country than it was during the 17th and 18th centuries, owing to the increase in the urban population.

It has been said that the real test of the sanitary condition of a community lies in the low infantile mortality; if this be correct, then I am afraid that we cannot pride ourselves on achievements in sanitation, - for our infantile mortality has practically remained stationary during the last 40 years, in spite of all our endeavours to reduce it.

If we compare the death-rate of infants in London, say 35 years ago, with what it is today, we find that, whereas the birth-rate has fallen 15 per cent., the infantile death-rate has only fallen about 3 per cent., and that the diarrhoeal death-rate, - thanks to a better system of death certification and more careful diagnosis, - has fallen nearly 35 per cent. from what it was in 1871.

Whilst this is true for London, the very reverse, so far as infantile mortality is concerned, obtains for the rest of England; this, as has already been explained, is due to increase in size and number of other large towns throughout the provinces.

According to ~~the~~^a special report of Dr. Robinson, Medical Officer of Health for Birmingham, epidemic diarrhoea caused 15,263 deaths during the five years ending December, 1904: this, so far, appears to be the highest figure for that city since the year 1837.

The number of deaths from this disease in Liverpool, according to the Annual Report of the Medical Officer of Health for 1904, was 1785, of which 1640 were in children under 2 years of age, ~~or~~^{all} 2.046 per 1000 living at ~~that~~^{all} ages. During the year 1904, the number of deaths from zymotic

disease, under 1 year, was 1629, of which 1200 were due to diarrhœa alone, - nearly 74 per cent. of the total zymotic deaths under 1 year were due to diarrhœa alone!

Exactly the same, or even worse, appears to have been the case in Manchester. In fact, there is scarcely a town of over 20,000 inhabitants in the whole of Lancashire and Yorkshire, which does not show a death-rate from epidemic diarrhœa of over 1 per 1000 living at all ages; for those living under 1 year it probably constituted about 25 per cent. of the total deaths from all causes.

There is no other disease with which we are acquainted, that furnishes anything like the same percentage of deaths; measles, the only other disease which at all approaches epidemic diarrhœa in its virulence, is only responsible for about 4 per cent. of the total deaths under 1 year.

Dr. Hunter, Medical Officer of Health for Paisley, says that the death-rate from epidemic diarrhœa and measles has remained stationary since 1837, whilst the general infantile mortality for that populous place has fallen over 50 per cent. in the same time.

The statistical returns from other countries appear to indicate an even higher diarrhœal death-rate: for instance, Henri Monod, - writing to the French Academy of Medicine, in July, 1901, - shows that of the total number of deaths in Paris, nearly 40 per cent. of those dying under 1 year of age do so as the result of epidemic diarrhœa.

From America and Germany, the reports give almost the same high figure.

From the above examples we are justified in concluding that epidemic diarrhœa is one of the most fatal diseases of infancy or early childhood, and that hitherto the efforts to control the ravages of the disease have not been attended with the measure of success that has marked the decline of nearly all the diseases with which we are acquainted.

I believe that, as our knowledge of the disease increases, and a more uniform system of filling up death certificates [such as that recommended by the Royal College of Physicians of London] becomes general, - the disease, instead of showing a decline, will actually be established as on the increase, unless the State will do something to guard against this unnecessary sacrifice of infant life.

There is no doubt that a large proportion of the deaths returned, during the summer months, as due to tuberculosis

of the bowels, teething, convulsions, colic, gastritis, etc., in infants under 2 years of age, are undoubtedly cases of epidemic diarrhœa, which a strict observance of the instructions given by the Registrar-General would soon prove to be so.

It is not only the number of infants which the disease carries off each summer that we must bear in mind, but the even more numerous cases of infants who, as a result of the malady, suffer irreparable injury to their constitutions. It has recently been stated, ~~however~~, that for every infant who dies from epidemic diarrhœa, 5 are ruined in both health and constitution from having passed through one or more attacks. My own experience is that the proportion is higher, so far at least as the infants of the poor are concerned. Rilliet and Barthez, already quoted, state that "taking into account all the cases observed post-mortem, including those of tubercular disease, of every two children dying, one presents a more or less serious lesion of the large intestines; it is rare for a child dying between the ages of 2 - 5 without having either had colitis or softening of the large intestines".

ETIOLOGY.

Before dealing with the etiological factors ^{in order} in the production of summer diarrhoea, it will be necessary, to appreciate the meaning of these factors as bearing on this condition, to ^{briefly} ~~pass in review rapidly~~ the anatomy and physiology of digestion and assimilation.

ANATOMY AND PHYSIOLOGY OF THE ALIMENTARY TRACT.

STOMACH.

The stomach of the infant at the age of three months is capable of containing about 7 or 8 ounces, at six months 10 or 11 ounces, and at 12 months it can hold about 18 ounces of fluid.

At birth the infant's stomach, when distended with food, represents a somewhat globular swelling at the lower end of the œsophagus; the fundus is very imperfectly developed, and the greater curvature of the organ is almost absent, - the whole stomach, when empty, resembling a simple dilatation between the end of the œsophagus and the commencement of the duodenum. The subsequent increase in size of the organ towards the left of the mesial line, results in the unequal bulging of the viscus, and gives rise to what is called the larger, or greater, curvature. From this we can readily understand how easy it is for the contents of the stomach to escape in either direction, should anything occur to cause irritation of that organ.

The reaction of the contents of the stomach during digestion is always acid from the presence of hydrochloric acid, which is secreted by a set of ~~glandose~~ glands situated near the cardiac end of the organ. The quantity of hydrochloric acid secreted depends on the age of the infant, its state of health, and the kind of food taken. Leo has estimated it at about 1 to 2 parts in each 1000 part of stomach secretion. It is present in the stomach of the newly born infant. In children fed on milk it combines with the albumin which it coagulates in conjunction with the rennin (a milk-curdling ferment secreted by branched glands near the pyloric end of the stomach), and any hydrochloric acid

which remains unchanged goes to provide an acid medium in which the proteid-splitting ferment, peptozinogen, can act; it is also believed that free hydrochloric acid protects the gastro-intestinal tract from the invasion of pathogenic micro-organisms.

Lactic acid is not normally present in the stomach of healthy breast-fed infants, but is usually found in the case of hand-fed children. Heubner found as much as 1 to 2 parts of lactic acid in every 1000 part of the gastric contents.

Pepsine is found in the stomach of infants at birth. Its action is to break up the proteid molecule into albumose and peptone; this, as explained already, can only take place in an acid medium, -so that, apart from its antiseptic properties, the action of hydrochloric acid in the case of infantile digestion is a very important one.

The reaction of the food is of great importance in the case of infants, so far as the peptic digestion is concerned. Human milk being always alkaline, its casein is not ~~at once~~ ^{immediately} coagulated into large masses, as occurs in the case of ~~the~~ neutral or acid food ^{given}, when cow's milk constitutes its basis; the alkaline milk uses up more of the free hydrochloric acid to neutralise it, and combines with its salts, the coagulation of the insoluble casein being delayed; this favours peptic digestion; and for this reason lime-water is sometimes added to the milk to give it an alkaline reaction.

It has been found that hand-fed infants require, as a rule, half to one hour longer to digest a meal than children nursed at the breast. Whether the hydrochloric acid of the stomach possesses any inhibitory action on the bacteria entering the stomach with the food during healthy digestion, is a very difficult question to settle, especially in the case of infants whose digestive organs are so easily influenced by the nature of the food given, or by slight nervous disturbances which, in the adult, would pass unnoticed.

Hewitson has made a series of careful experiments into the agency of the gastric juices in guarding against the bacterial invasion of the stomach. From his conclusions we are led to think that, so far as the healthy adult is concerned, the gastric juice is capable of inhibiting the growth of almost all putrefactive bacilli and pyogenic cocci. He found, moreover, that the latter were killed in 30 - 40 minutes; the former in one to one and a half hours; but that if digestion were delayed by the presence of worms or of an

ulcer in the stomach, the bactericidal properties of the gastric juice were greatly diminished.

Lorraine Smith and Tennant have confirmed Hewitson's experiments in the main; they believe that the healthy gastric secretions are capable of controlling bacterial growth in the stomach, and that anything that retards digestion favours the multiplication of bacteria in the contents of the stomach and intestines.

Miller has examined the gastric contents of children during and after digestion, and finds that the amount of free hydrochloric acid necessary to inhibit bacterial growth was 1.6 parts in each 1000 parts of the stomach contents; but, according to Van ^{Purkin} ~~Putusen~~, this amount of acid is never reached in the case of infants under 2 years; and, with Czerney, he holds that the chief protection from bacterial invasion depends, not so much on the amount of free hydrochloric acid, as upon the performance of healthy digestion, and rapid assimilation leaving little food residue on which the growth of organisms can occur, and in which fermentative changes can take place.

Whether or not the quantity of free hydrochloric acid in the stomach ever reaches that amount necessary to inhibit the growth of pathogenic germs, is a question difficult of solution; but one thing, however, has been proved, viz., that, given an active peptic digestion and a speedy absorption of the nutritive portion of the food, we seldom have much need to fear any dangerous invasion of the alimentary canal by the bacteria which have gained access by the mouth.

INTESTINES.

Like the stomach, the intestines are lined throughout with columnar epithelium. The mucous membrane of the small intestines is folded into transverse ridges, so as to give a greater area of contact with the food, assist^{ance} in the digestion of fats, and the absorption of chyme; but they are absent from the first part of the duodenum and the lower end of the ileum. Throughout their whole course the small intestines are studded with various kinds of secreting glands.

Brunner's glands, ^{are confined to} in the upper part of the duodenum, ^{and} are a continuation of what have been already referred to as the pyloric glands of the stomach. Lieberkühn's glands are found distributed throughout the whole length of the small and large intestines alike. Peyer's patches and lymphoid follicles

also occur in the small intestines, the former especially in the lower two-thirds of the ileum, and the latter in both the small and the large intestines. They are not glands at all, but merely aggregations of lymphoid tissue, whose physiological functions are as yet but imperfectly understood. Some believe that the secretion of Lieberkühn's glands have the power of changing maltose into glycerine.

The junction between the small and the large intestine is marked by the ileo-cæcal valve, which guards against regurgitation of the contents of the latter into the former.

The muscular arrangement of the stomach and intestines consists of involuntary muscular fibres, arranged in several layers, running for the most part transversely and longitudinally to the axis of the gut.

Both the stomach and the intestines are richly endowed with blood-vessels, nerves, and lymphatics; and the small intestines have, in addition, a set of vessels called lacteals, which are concerned in carrying away the products of fat digestion.

The nerves of the stomach and intestines are derived from the pneumogastric and sympathetic, which form numerous plexuses in the abdomen, as well as between the muscular layers of the stomach and intestines. From the widespread distribution of the sympathetic fibres to every part of the body, and the intimate association of the pneumogastric with the heart, lungs, pharynx, larynx, and spleen, - it can be readily understood how any central or peripheral disturbance of these nerves will lead to serious constitutional disturbance, the correct interpretation of which may not be at once apparent. The fibres of the sympathetic contain vaso-motor and vaso-constrictor nerves, which regulate the blood-supply for the glandular structures situated in the stomach and intestines. The pneumogastric fibres appear to preside over the secretory function and muscular tone of the alimentary canal; for it has been proved that division of the vagus nerve stops not only the secretion of the gastric and intestinal juices, but also paralyses the intestinal movements. The centre concerned is situated near that of the central nuclei of other nerves which have to do with the innervation of the heart, lungs, and diaphragm; anything, therefore, which stimulates the termination of one of these nerve-trunks may have widespread effects.

Except for a small portion at the upper end of the

duodenum, the contents of the intestines are always alkaline in health; for trypsin, the proteolytic ferment which enters the duodenum from the pancreas, can only act in an alkaline medium. The action of this ferment is to complete the proteid digestion begun in the stomach. In addition to trypsin, the pancreas secretes (1) a ferment which converts the starches into maltose; this ferment is the case of infants is absent until about 4 or 5 months after birth, and then only in small quantities. ~~Until the child reaches the age of five months,~~ Trypsin has a more powerful action on the starch than the ptyaline of the salivary glands, which, by the way, does not make its appearance until the infant is three months old. (2) A fat-splitting ferment, called steapsin, which, in conjunction with the bile, converts fats into fatty acids and glycerine; the acids unite with alkaline bases to form soaps, whilst some of the fats are emulsified and absorbed by the lacteals as chyle.

B A C T E R I O L O G Y.

The presence of bacteria in the alimentary canal of infants, almost from birth, shows that such habitation may possibly be associated with a useful purpose in the changing of food elements into soluble molecules able to pass through the epithelium, and so reach the blood-vessels and lacteals.

BACTERIA AND THEIR RÔLE IN HEALTHY DIGESTION.

The chief varieties of bacteria found in the intestines of healthy infants belong to the putrefactive group of germs. This Escherich believes to be due to the exclusive nature of the infant's food, and the absence of a free supply of oxygen; and it is possible that by their action on sugar and carbohydrates other varieties can ~~be produced.~~ ^{Sometimes gain an entrance.}

The most constant varieties found in the alimentary canal of the infant are the bacterium lactis aërogenes, and the bacterium coli communis. The former is found chiefly in the stomach and the small intestines, the latter occurs in the largest numbers in the cæcum and colon. Several varieties of micrococci, torula, and sarcinae may also occur, together with the bacillus proteus and, in hand-fed infants, the bacillus enteritidis sporogenes of Klein.

The chief action of bacteria during health appears to be the formation of such acids as carbonic, lactic, and butyric from sugars and starch; they are also capable of carrying proteid digestion further than is possible by the agency of the pancreatic ferment, - with the production of such gaseous substances as indol, skatol, and phenol; it is also believed that they **help** in the saponification of fats: for, contrary to former teaching, it has now been proved that the bile acids have no inhibitory action on the growth of micro-organisms in the intestines. Bacteria may sometimes prove beneficial owing to the power which they possess in changing the chemical composition of toxic substances formed during intestinal digestion. For example, choline - an alkaloid derived from lecithin during pancreatic digestion - is, by the agency of bacteria, decomposed into carbonic acid, methane, and ammonia.

From the foregoing remarks it will be seen that, although the variety of bacteria inhabiting the alimentary canal of infants during health are few, they nevertheless play an important part in the complete digestion of foods; and, as long as their numbers are kept within bounds and not allowed to invade the upper portions of the small intestines and stomach in large numbers, their action is a beneficial one. But, in certain children, especially those fed on sour or stale milk teeming with both putrefactive and pathogenic germs, this useful balance is very easily upset, - the result being a multiplication in numbers, and an increase in the virulence of the already existing bacterial flora. Normally very few bacteria find their way into the small intestines; but, if digestion be interfered with, such as occurs in dyspepsia or in catarrhal states of the stomach, bacteria are found to invade the small intestines in large numbers, where they may produce toxins and other poisonous alkaloids, which in their turn are capable of setting up profound physical and mental symptoms, as will be seen when we come to describe the manifestations of epidemic diarrhœa.

The fœces of healthy infants exhibit the same varieties of micro-organisms as we have already seen occurring in the stomach and intestines, with the exception that the bacterium *Lactis aërogenes* seldom occurs in large numbers in the stools, being, as we have seen, usually present only in the stomach and small intestines.

Uffelmann, who has made a careful investigation of this subject, in order to determine the part played by bacter-

ia in disease, found that the fœces of healthy sucklings,

contained large numbers of micrococci and bacteria, the latter class predominating and belonging chiefly to the colon group. Compared with the faeces of healthy adults, that of the breast-fed infant contains relatively few varieties. *of bacteria.*

Bacterium Lactis Aërogenes.

Booker has investigated the action of this organism in the case of guinea-pigs and rabbits. Fresh cultures, when injected into the blood-vessels of these animals, caused symptoms of collapse, with diarrhoea and intestinal catarrh, ending in death, in some cases within a few hours. He believes that, owing to the rapidity with which the symptoms made their appearance, this organism acts as a toxic agent rather than as a direct irritant of the intestinal mucous membrane. They are present in largest numbers in the large intestine of infants fed on milk diet, especially hand-fed children during the summer months, and they are absent from the faeces of those subsisting on a flesh diet.

Bacterium Coli Communis.

This organism, as it occurs in nature, is characterised by great variation in its morphology and biology. It is scarcely ever absent from the faeces of infants during health, and both its numbers and virulence are greatly augmented with the occurrence of pathological changes in the stomach or ~~in the~~ intestines. In the case of adults this is particularly well seen in typhoid fever, yellow fever, and other diseased processes, where it doubtless plays a very important part in the production of the symptoms of those diseases. In the epidemic diarrhoea of children, this organism is found in abundance in the stools, sometimes, indeed, it is the only one present; cultures made from these stools may yield almost pure growths of this organism; and such growths, when injected into guinea-pigs and rabbits, give rise to symptoms of profound toxæmia.

Like the bacterium lactis aërogenes, its numbers become greatly increased in dyspeptic and catarrhal conditions of the stomach and intestines. During health it is only found in the large intestine, but in the above-mentioned conditions it invades the small intestines, and even the stomach, where it may multiply and form toxins.

To carry the simile still further, like the bacterium lactis aërogenes, it can produce coagulation in milk. Bandwéhr thinks that it is concerned in some way

thinks that it is concerned in some way with the decomposition of intestinal mucus, from which it derives its nourishment. This view is certainly strengthened by the way in which this organism multiplies during catarrhal and inflammatory affections of the mucous membrane. During health, nearly all the products of digestion are absorbed in either the stomach or the small intestines; so that the colon bacillus must either derive its sustenance from the mucus, as explained by Landwehr, or from the residue which passes from the small intestines.

The colon bacilli sometimes occur in large numbers in milk, especially if it be kept for some time exposed during the dry summer weather.

BACTERIOLOGY OF THE DIARRHOEAL STOOLS.

It is here necessary to compare the bacteria already seen to exist in the healthy milk-fed infant, with those isolated from the stools of children suffering from epidemic diarrhœa. It is a fact, - well established in the case of many other specific diseases, such as, we have already seen, in typhoid, for instance, and which is also the case in pneumonia and diphtheria, - that the growth and pathogenicity of various forms of bacteria may be considerably altered when grown in conjunction. We must also bear in mind that the process employed in isolating disease germs may have considerable effect in altering their virulence.

The bacteria found in diarrhœal stools differ very little in variety from those found in the healthy infant fed on cow's milk. Some of these we have already studied; and, for the most part, they present the same morphological and biological characteristics. Their energy appears to be chiefly expended upon the production of chemical changes either inside or outside the body, so that digestion and assimilation become impeded. The ultimate result of this is that irritation of the mucous membrane occurs, which same, unless corrected by appropriate means, may result in an attack of catarrhal dyspepsia or diarrhœa.

The present research has been undertaken by me with a view to determining what part the normal bacterial flora of the alimentary tract play in the etiology of summer diarrhœa; whether the disease under consideration depends solely upon an increase in numbers and virulence of those we have already mentioned; and, if so, to which group this property belongs.

Failing this, it becomes necessary to find out if other varieties of bacteria may not gain entrance to the alimentary tract during the preliminary dyspeptic stage of the disease, that is to say, when the defensive action of the gastric juices is in abeyance, and, by virtue of their specific properties, give rise to the symptoms associated with epidemic diarrhœa.

Valpino, in a review of the action of the various bacteria associated with summer diarrhœa published last year, affirms that the majority belong to either the colon or the paracolon group, and in all probability a variety of the bacillus coli communis of excessive virulence. In the course of his bacteriological researches, at Tunis during an epidemic of this disease, he isolated from the diarrhœal stools a bacillus morphologically identical with the bacillus coli of Escherich, and another in many respects presenting the same characteristics, and which he names the bacillus enteritidis infantum. The latter organism is a motile bacillus, resembling somewhat the bacillus typhosus in its growth upon agar; it does not liquefy gelatine; coagulates milk only with difficulty, or not at all; does not produce indol in peptone broth; in its growth upon glucose-agar it gives rise to the formation of gas ~~and of acid~~; and it does not retain the stain in Gram's method. From experimental inoculation this bacillus appears to be more virulent than the bacillus coli, so far at least as the animals employed were concerned; in the case of man, when given by the mouth, it caused diarrhœa with green stools, from which the organism could easily be isolated. It was found that the serum of infants, suffering from ordinary summer diarrhœa, was possessed of the property of bringing about agglutination of fresh cultures of the organism, in 1 in 60 dilution. The same investigator has isolated it from the stools of infants fed on cow's milk, but who were not suffering from diarrhœa. Valpino claims for this bacillus enteritidis infantum the specific property of causing epidemic diarrhœa. This, however, is rather too much to affirm, for an organism which, as he has shown, belongs to a group of bacteria constantly found in the feces of most infants during health; as we have already seen, its morphological characteristics, (which Valpino has carefully worked out) ^{may} differ from those of the common members of the group, but the manner in which many of these approach those of the bacillus typhosus is of considerable interest, as showing

how difficult it may sometimes be to decide between members belonging to the colon group and the typhoid bacillus.

Booker, who has examined 30 cases of diarrhæal stools, 11 of which were cases of true cholera infantum, found that the ~~members~~ ^{were} of the colon bacillus group represented, in every case, the largest numbers occurring in the cases of cholera infantum, and diminished in numbers in cases of colitis with dysenteric stools. The bacillus lactis aërogenes was always present in larger numbers than during health, but he did not think that their presence had any casual connection with the condition under discussion, for some of the worst cases only presented very few colonies. Of the bacteria which are chiefly found during the course of epidemic diarrhæa, and which are only present in very small numbers, or entirely absent during health, the one most constantly present in the 30 cases which Booker examined, at the Johns Hopkins University, was the bacillus belonging to the proteus group: it occurred in 7 out of the 12 cases of cholera infantum examined. The most constant members of this group occurring in the stools was the proteus vulgaris. Booker isolated another member of the proteus group, which he calls the A bacillus. This is a somewhat long, narrow bacillus, with rounded ends, differing from the proteus vulgaris in coagulating milk with an acid reaction, and in rendering acid milk alkaline.

Most of the members comprising the proteus group are to be found widely distributed in nature, where their chief action consists in causing the putrefactive decomposition of animal matter, with the production of ptomaines and maledorous gases. Normally they are absent from the stools of healthy breast-fed infants, as well as those fed on sterilised cow's milk. This is doubtless due to the fact that, during healthy digestion, all the albuminous compounds in milk quickly become absorbed, thus affording little pabulum on which this variety of bacteria can multiply. It is only in the case of defective assimilation, where casein remains in the intestines for some time, that the presence of the organism becomes evidenced. This condition of affairs is amply provided for by the preliminary catarrhal dyspepsia, which, we have already seen, so frequently determines the onset of the symptoms of epidemic diarrhæa; and, as we have already noted in the case of the members of the colon group, constitutes a favourable opportunity for the invasion of the intestines and stomach by large numbers of ~~of~~ both groups. Milk cultures, made with

the members of the proteus group and given to mice and guinea-pigs, produce signs of stupor and rapid emaciation, ending in death from one to eight days. The organisms were afterwards found in large numbers in the stomach, intestines, and kidneys. The autopsies showed no lesions of the alimentary tract; diarrhœa was only present in about 76 per cent. of the animals experimented with. Bouillon cultures, ten weeks old, when injected into the vein of a rabbit's ear, caused death in from two to twenty hours. During life, the animal presented symptoms almost identical with those seen in the case of infants suffering from cholera infantum - viz., profuse watery diarrhœa and restlessness, followed by coma and death.

Of the 5 cases of diarrhœal stools which I have examined bacteriologically, 1 of which was a case of cholera infantum, I was able to isolate and identify the proteus vulgaris in only 2, - 1 a severe case of ileocolitis, the other a case of cholera infantum. The child with the ileocolitis was a bottle-fed, delicate infant who, three weeks previously, had an attack of severe diarrhœa and vomiting, with other symptoms of catarrhal dyspepsia, from which it was making a good recovery: but, owing to some dietetic error, it was attacked with diarrhœa and vomiting, pains, and speedy collapse, the stools being acid, of a greenish-yellow colour, and very offensive. I tested the pathogenicity of the cultures of the bacillus from the case of cholera infantum. Milk cultures, twenty-four hours old, were made and given to kittens, but without much appreciable effect. But when the same cultures were kept for from forty-eight to sixty hours and then given to kittens, death followed in from two to five days, with symptoms of diarrhœa and drowsiness, elevation of temperature, thirst, and indifference to food. When a four days old bouillon culture, previously heated to 80°C., was divided into two portions, and a moiety given to each of the two kittens, the first died in less than six hours without any diarrhœa, but with much evidence of collapse, thirst, and attempts at vomiting; the second, after the lapse of eleven hours, presented symptoms of high fever, ^{thirst} thirst, vomiting, and very profuse green coloured diarrhœa with an acid reaction. During these experiments the kittens were allowed to drink only the mother's milk. As possibly bearing upon the contagious nature of the disease thus produced, I may mention that two companions of the second kitten, which ~~were~~^{were} given the bouillon cultures, developed symptoms of gastro-enteritis three days after their companions received the bouillon culture of the proteus vulgaris; and one died six days after-

wards with symptoms of severe diarrhœa, loss of weight, pyrexia, dry condition of its fur, and general nervous prostration. The autopsies on these two kittens revealed no definite lesions in the whole of the alimentary canal; here and there were patches of hyperæmia ^{were} found, especially in the transverse colon; none of the organisms experimented with were found in the blood or kidneys, although they were abundant in both the large and small intestines, and relatively few in the stomach.

Bouillon cultures, similarly prepared and sterilised, which I swallowed after three hours of fasting, were without effect on myself, - except for a little nausea and slight acceleration of the pulse-rate.

In order to test the vitality of the organism in water, I placed a little of a pure culture in two gallons of that liquid drawn from the tap. After two days I failed to get any growth of the proteus vulgaris in bouillon inoculated ^{with} ~~into~~ this water. If instead a milk culture of the proteus vulgaris were added to the water as above, cultures of the organism were obtained after five or six days, but their virulence appeared to be considerably diminished after the first thirty-six hours of sojourn in the water.

These experiments go to prove what I have already said, namely, that the members of the proteus group require for their growth and multiplication some albuminous compounds on which they can feed; for, when this is absent, as in tap water, they quickly perish.

The result of these ^{experiments would so} ~~conditions~~ is to show that, the more ~~undigested~~ the casein and the other albuminous compounds which remain unabsorbed in the intestines, the greater the chance there is for the vital phenomena of this group of bacteria to manifest themselves.

There would appear to be some evidence to show that, given a favourable opportunity, such as occurs in impaired states of gastric and intestinal digestion, the bacillus proteus is capable of causing some putrefactive changes in the food-residue, which, if left alone, may end in severe diarrhœa; but, whether this ^{result} ~~residue~~ is obtained by the invasion of the tissues by the organism, or by the toxins which it manufactures from the food, remains undecided: possibly both methods occur in the severe cases.

In addition to the bacillus proteus, I also isolated certain members of the colon group, ~~such as~~ the bacillus lactis aërogenes; and in one case I found numerous cocci, which, for

the most part, resembled the staphylococcus albus; torula and sarcinae were found in abundance; but I was unsuccessful in my efforts to detect the presence of the bacillus enteritidis sporogenes, although the investigation was undertaken mainly with this object in view.

Bacillus Enteritidis Sporogenes.

This organism was first isolated by Klein, in 1895, from the stools of a number of patients admitted to St. Bartholomew's Hospital suffering from severe diarrhoea and vomiting; which had relation to the consumption of milk, in which, indeed, the same organism was subsequently found.

Klein has also isolated it from the stools of infants suffering from summer diarrhoea. Booker has found it in the stools of infants suffering from gastro-enteritis, and also reports its presence in the spleen, kidneys, lymphatics, and the mesenteric glands of infants who presented symptoms of summer diarrhoea during life. Libmar, Hirsch, and Escherich have all found it present in outbreaks of diarrhoea in children. The last-mentioned observer regards the bacillus enteritidis sporogenes as the ectogenous infective agent in his classification of ~~the~~ summer diarrhoeas.

The organism in question is a constant inhabitant of sewage, polluted soils, and well-water into which sewage or drainage flows. It is an anaërobic bacillus, 1.5 to 4 mm. in length, and about .5 mm. broad. As its name indicates, it forms spores. It grows on ordinary media, and retains the stain in Gram's method.

Its culture characteristics are best studied in milk, which is also found to be the most useful medium for effecting its isolation. It causes coagulation of the casein, and complete separation of the curd from the whey, and, after thirty-six hours at 37°C., an abundant formation of gas. The whey is found to be acid, from the presence of butyric acid, and to contain the bacilli in large numbers. When a small quantity of such whey is injected into a guinea-pig, it sickens and dies inside twenty-four hours; at the point of inoculation the tissues are found to be œdematous, often gangrenous, and emitting an evil odour.

This organism appears to multiply locally, for it was not found in any great number in the blood-vessels or internal organs of the animals used for the purpose of experiment. It is possible that in such cases they produce a toxine at the point of inoculation, which becomes absorbed into the sys^{tem}

and brings about the death of the animal.

Dr. A. E. Carver reported on an outbreak of infective colitis; which attacked 25 or 30 infants, many of whom were treated in the Great Northern Hospital, London. He found the bacillus enteritidis sporogenes present in large numbers in all the cases in which the contents of the colon were examined. The large intestine was the invariable seat of infection, its walls being thick and swollen, and in some places presenting ulcers. Dr. Carver has adduced evidence pointing to the possibility of drinking water being the channel by which the organisms gained entrance to the system in this particular instance.

Hewlett and Glynn have shown that this organism is ordinarily present in the stools of healthy adults; but, so far, there is no evidence to show that the same obtains in the case of infants, although we have abundant proof that it frequently occurs in stale milk during the summer. Escherich believes that it may find its way into milk on dried particles of dust, or be derived from the teats and udders of cows.

It appears to be also possible for the organism to gain access to the milk through the water used in washing the milk cans, or during the process of diluting the milk - a practice that is said to be by no means uncommon amongst milk vendors.

When we remember how excellent a medium is provided by milk for the growth and multiplication of this organism, especially during the hot summer weather, it is not difficult to understand why the ingestion of such milk by infants may quickly result in an attack of simple dyspepsia or diarrhoea. Further, it is significant to note that the bacillus enteritidis sporogenes is frequently associated with the members of the colon group in polluted soils and sewage, and also the fact that their interaction during their sojourn together may have the effect of increasing theirⁿ pathogenicity.

I have found this organism in three samples of milk examined. This milk had been previously procured from the homes where cases of diarrhoea existed. One sample contained as many as thirty colonies per c.c.; and when some of it was given to a kitten, symptoms of depression and diarrhoea occurred within eight hours.

I am inclined to think that there is some evidence to show that the bacillus enteritidis sporogenes plays a rather important part in the causation of summer diarrhoea in

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infants fed on cow's milk, especially if the latter be kept unprotected from dust, or adulterated with impure water. Whether this organism is capable of giving rise to diarrhœa through the chemical changes which, we have already seen, it is capable of causing in milk before it enters the stomach of the infant, or from its growth and vital activities after entering the alimentary canal, - it is difficult to say; but, from the rapidity with which the symptoms supervene in the case of animals fed on milk cultures, I am inclined to conclude that it is capable of producing toxins in the milk, - for the slight degree of acidity would not explain the rapid depression of the sympathetic nervous system and heart seen after the ingestion of such milk.

Hayem and Lesage, in 1887, isolated from the intestinal contents, in cases of green diarrhœa in infants, a bacillus of about the same size as the colon bacillus, and to this they attach considerable importance. It grows in long filaments, 2 mm. or more in length, causes a green colour to diffuse throughout any medium in which it is grown, and is said to form spores. It is found not only in the stools and large intestines in cases of green diarrhœa, but also in large numbers in the small intestines. The stools in these cases are always acid or neutral in reaction. Hayem and Lesage believe that both the green colour and the acid reaction are due to the presence of the bacillus; but Pfeiffer denies this, and says: "This green colour depends on a pathological alkalinity, occurring somewhere in the intestinal tract, which changes the bilirubin into bilivuridin". He succeeded in causing green stools by giving infants large doses of sodium bicarbonate. Hayem and Lesage gave young animals milk containing this chromogenic bacillus, and, after a lapse of twelve to sixteen hours, green diarrhœa resulted; the bacillus being found in the stools and upper part of the small intestines. Similar results were obtained when pure cultures were injected directly into the blood-vessels of rabbits, but there was no response to hypodermic injections. When old animals were used, even intravenous injections were unsuccessful.

From ^{standpoint} a clinical, we must regard green diarrhœa as being very contagious amongst infants. At St. Anthony's Hospital in New York, the outbreak of diarrhœa was invariably preceded by the introduction of a case of green diarrhœa; but, so far, this chromogenic organism has not been found in either milk or water. The chief agency in its spread is believed to be

soiled diapers, and want of cleanliness on the part of either the mother or nurse.

Baginsky has been able to isolate two bacilli resembling Hayem and Lesage's chromogenic organism, from cases of green diarrhoea in infants; and, from the results of experiments on animals, he is inclined to think that this bacillus of Hayem and Lesage plays an important rôle in the causation of the summer diarrhoea of infants.

I have made a careful study of green stools, but have failed to find any bacillus possessing chromogenic properties, similar to those seen in connection with the bacillus of Hayem and Lesage, when grown on artificial media. Nor has Booker been able to detect the presence of this bacillus in 30 cases of diarrhoeal stools examined, although he isolated no less than forty varieties of micro-organisms from these cases - some cases showing as many as eight different species of bacteria. Both Lesage and Escherich found a diminution in the number of the bacillus lactis aërogenes in the small intestines in cases of green diarrhoea. There appears, moreover, to be no evidence at present to show that green diarrhoea is etiologically different from ordinary diarrhoea, for, during the course of the latter disease, green stools are usually found after the first three or four days of illness.

Among the other micro-organisms sometimes found in diarrhoeal stools, mention may here be made of the bacillus pyocyaneus, - first isolated from the stools by Baginsky, - the bacillus subtilis, the bacillus mesentericus vulgaris, and the tritrothrix tenuis - none of which have been found in the stools of healthy infants fed at the breast.

Lewis C. Parker records a case [Brit. Med. Jour., Nov. 5, 1905] where the bacillus prodigiosus appears to have caused an outbreak of diarrhoea in a large country mansion containing eighteen persons, nearly all of whom were attacked by diarrhoea, except a child which consumed milk only. The writer in this article is inclined to believe that this outbreak was due to the consumption of food stowed away in a larder, which drew its supply of air from an enclosed yard, with defective pavements, into which hot steam escaped from a hot water cylinder. The meat was examined, and found to furnish a pure culture of the bacillus prodigiosus. This case is interesting in this connection, and also because the bacillus prodigiosus has hitherto been regarded as a harmless organism. The bacillus pyocyaneus and the bacillus subtilis have been isolated from numerous cases of suppurative appendicitis,

but there

but there is little to show that they play any important rôle in the production of diarrhœa.

In connection with Parker's cases, mention should be made of the Welbecks disease, where Klein isolated from milk and other foods a bacillus, which morphologically resembles the bacillus typhosus. This bacillus is usually known by the name of Gärtner's bacillus, from its discoverer. In man it gives rise to symptoms of diarrhœa, vomiting, and abdominal pain, as well as pyrexia, ending in death from collapse in from one to four days. It has been found to possess very marked pathogenic properties when given to animals, either by the mouth or hypodermically. The bacillus has also been found in all the internal organs; and intense enteritis and swelling of the lymphoid follicles have been found after death in all the cases.

Klein, in his examination of 39 samples of cows' milk collected from different farms all over England, found Gärtner's bacillus in 25 per cent. of them ~~all~~. The same investigator, speaking of the large number of cases in which this bacillus was found in milk, and in view of its high pathogenicity to animals, says that it is disquieting "to reflect that such milk kept in a warm place or in the warm months of the year, might be fraught with undesirable consequences to the consumers owing to the milk being a good medium for the multiplication of this bacillus, and ^{also} owing to the character of the milk remaining unaltered."

Seven outbreaks of meat-poisoning have occurred in this country - notably at Middlesborough, Welbeck, Nottingham, Carlisle, and Derby; in each instance the bacillus of Gärtner was found ~~present~~ in the stools; and all the attacks were characterised by symptoms of profound toxæmia with diarrhœa and collapse.

In view of the investigations made by Klein, with regard to the bacteriological condition of cow's milk arriving in London, it is quite possible that the members of this group may in some cases be responsible for epidemic diarrhœa, occurring in infants fed on contaminated milk.

A report, recently published, by the Rockefeller Institute for Medical Research, Boston, upon the relationship of the bacillus of dysentery to infantile diarrhœa, affords evidence of the presence of the bacillus dysenteriae in the intestinal discharges of a large percentage of infants suffering from summer diarrhœa. This bacillus, however, was found in the largest numbers, not in the stools, but adhering to the mucosa, or

in the intestinal mucus, and the greatest number of colonies was obtained from the severest cases, some of which, indeed, gave almost pure cultures; but, for the most part, the usual intestinal bacteria were also present in greater or lesser number.

The bacillus dysenteriae of Holt and Flexer differs in some respects from the well-known bacillus dysenteriae, particularly in its action on ^{magnite} ~~maltose~~ and dextrine; but the serum of infants suffering from epidemic diarrhoea possesses no agglutinative properties towards Holt and Flexer's bacillus.

Out of a series of 64 cases of summer diarrhoea in infants occurring at Vanderbilt ~~Clinic~~, the bacillus dysenteriae was found in no less than 62 cases; and in all the cases examined by Holt and Flexer, exhibiting clinical symptoms of disease of the gastro-intestinal tract, of an acute character, and covering a year, - about half revealed the presence of the bacillus dysenteriae. It was not found in the stools of healthy infants, or only very rarely (1 in 24 cases), nor in infants dying from other intestinal affections.

Of the 237 cases examined by Holt and Flexer during the year, the bacillus dysenteriae was found in no less than 207, the true Shiga organism in only 23, and both in 7 cases. Although these investigators have demonstrated the presence of this bacillus in over 87 per cent. of the cases of summer diarrhoea in infants, they leave the matter there, and do not deny the possibility of ^{other} ~~another~~ infectious or toxic agencies being concerned in the production of epidemic diarrhoea.

Duval and Bassett have, in the main, confirmed the results obtained by Holt and Flexer. Out of 42 typical cases, they obtained evidence of the presence of the bacillus dysenteriae in the stools of infants suffering from summer diarrhoea. They further found it present in 1 or 2 cases in the mesenteric glands and liver. These investigators appear to have been more successful than Holt and Flexer with the agglutinative action of this bacillus towards the blood-serum of patients from which it had been isolated, or with the serum of other infants suffering from a similar complaint. Both Duval and Bassett are inclined to think that infantile summer diarrhoea is caused by intestinal infection with the bacillus dysenteriae of Shiga, which is etiologically identical with the acute bacillary dysentery of adults.

I have endeavoured to collect the results of the most recent investigations on this important etiological aspect.

of summer diarrhœa; for since it has been considered a specific infectious disorder, occurring in epidemics during the summer months, it would seem from what we already know regarding the part played by micro-organisms in other specific diseases, such as typhoid and diphtheria, that the elucidation of the bacteriological problem connected with this disease is most likely to afford us the best means of combating the fearful ravages hitherto contingent to the prevalence of this affection. Up to the present, however, we must confess that no single organism has been generally established as the specific cause of infantile diarrhœa; still, however, there is some collateral evidence to show that some groups, or group, of micro-organisms will ultimately be proved to be the etiological factor. At present I am inclined to look on the colon or paracolon groups as the most likely agents.

We have already studied the part played by the members of these groups and the result of injecting them into animals; we have further seen that they are normally present in large intestines of infants during health; and that milk, the basis of almost all infant food, frequently contains large numbers. It is very probable that there are many species of the colon group, which have hitherto escaped the investigations of bacteriologists. Although much light has been thrown by recent studies of the members of this group, we are still ignorant as to the manner in which they change their toxic properties when present in conjunction with other pathogenic organisms, and as to the manner in which they take on the virulent characters of the latter. As an example of this we may cite the case of typhoid fever, in which the bacillus coli communis exhibits many of the pathogenic properties of the latter.

The majority of bacteriologists are agreed that the colon and typhoid bacilli belong to two distinct species, but it has not yet been proved that the one may not be changed into the other under conditions such as exist in typhoid fever, on the one hand, or acute enteritis, on the other. In the intestines of man, constant and exceedingly complex physiological changes are going on, which may have the effect of altering the whole character of any organism present, which, with the means at our disposal, it is impossible to imitate during the procedure of experimental research, so that we are not in a position to study the complete life cycle as it occurs in the natural state.

Dr Morgan has recently published the results of a preliminary investigation on the bacteriological examination of the stools of 58 infants who presented all the clinical symptoms of acute infective or catarrhal diarrhoea (28 of the former and 30 of the latter type of the disease). His research, which up to the present is the most exhaustive and carefully conducted one, of recent times in this country, was carried out in the bacteriological department of the Lister Institute of Preventative Medicine. After including all the more common lactose-fermenting and gelatine-liquifying intestinal bacteria in the 58 cases examined. One of them which he calls, bacillus No 1, occurred in the 28 out of the total number of cases, (in 11 out of the 28 cases of infective, and 17 out of the 30 cases of the catarrhal form of the disease) and in 17 cases out of the 28 in which it occurred, it was the only lactose non-fermenting organism present. This No 1 bacillus of Morgan, is a small motile, rod-shaped bacillus, shorter than the *B. typhosus*, and like the latter multi-flagellated and to which it appears closely related, both in its morphological and biological characters. Hitherto this organism has not been found associated with any other disease than the one under discussion, neither has it been isolated from the healthy stools of 20 infants under 2 years of age, which were examined by Morgan, and used as control cases, nor has it been found in sewage or water so far as Huston's reports show.

According to Morgan this bacillus appears to possess a high degree of pathogenicity towards young rats and rabbits, but only when directly introduced into their digestive organs tract; death, which usually followed in about twenty four hours after the ingestion of the organism, was frequently preceded by profuse diarrhoea and symptoms of collapse. After death the same organism was frequently found in pure cultures in the spleen, and in some cases in the heart's blood. The serum of patients suffering from epidemic diarrhoea, and from whose intestines this organism had been isolated, yielded somewhat dissappointing results, furthermore many sera of infants from whom this organism was isolated, agglutinated not only Morgan's No 1 bacillus, but also the *B. typhosus* and the *B. dysenteriae* of Flexner and Shiga. Another bacillus, which Morgan names the No 3 bacillus, and which he found in only 5 of the stools examined, exhibited pathogenic properties toward young rats when given by the mouth, but the dose required to be much larger than in the case of the No 1 bacillus; none of the animals experimented upon presented symptoms of diarrhoea before death. It was found that this No 3

From what has been said it would appear that no one species of organisms is responsible for the clinical symptoms and morbid changes seen in this disease, but rather that several varieties may contribute to its etiology, and these only, when the other factors favourable to the propagation of the disease are present.

An analogy may be drawn from the case of pneumonia and diphtheria already cited. We know that both Hoffman's bacillus of diphtheria, and Friedlander's diplococcus of pneumonia, normally occur in the buccal and bronchial secretions in health without giving rise to any morbid phenomena; although we know that both of these organisms are capable of assuming a very high degree of virulence towards the individual under certain imperfectly understood changes, either of the organisms themselves, or in the mucous membrane lining the throat and air passages. May not a similar occurrence be responsible for the production of diarrhœa? Here, as in the case of diphtheria, we have got a group of organisms constantly present in the alimentary canal, which, just like the bacillus of diphtheria, may become possessed of high pathogenic properties as the result of some exciting cause, such as alteration in the chemical or physical properties of the intestinal contents, or the same in connection with the lining membrane. Such a change occurs, we have already seen, during an attack of dyspepsia, or any other condition which interferes with digestion or assimilation.

ATMOSPHERIC TEMPERATURE.

Since attention was first directed to this disease, writers on the subject have placed special emphasis on the occurrence of epidemic diarrhœa during the hottest season of the year. The malady itself is commonly spoken of as summer diarrhœa, thus indicating its association with that portion of the year during which the temperature of the air is highest, and this association would appear to obtain so far as temperate and subtropical climates are concerned.

The seasonal curve of diarrhœa begins to rise in the middle of June, reaching its maximum about the end of July or the beginning of August, and slowly falls during the latter half of August and September; a more rapid decline occurs during October. It reaches its lowest point in the first or second week of November, after which there is little variation until the beginning of June. During very hot summers the death-rate may reach nearly 300 per cent. above the annual mean. The death-rate for the third quarter of the year, in some of our large industrial cities and towns, ranges from 60 to 96 per cent. of the total deaths, from all causes, in infants under two years of age.

There is a very definite connection between, not only the severity of the disease itself, but between the number of cases occurring in any given year and the height of the temperature of the air during the summer months; frequently one finds an alternation of years of high and low diarrhœal mortality, and this variation is found to be coincident with the height of the thermometer.

From the investigations of Meigs and Pepper, in America, it appears that, when the temperature of the air reaches 70° or 80°F., diarrhœal diseases begin to increase enormously amongst infants, especially in the large cities and towns; and this increase may reach to as much as 300 to 400 per cent. above the mean for the year.

Dr. Newsholm says that, "given two towns alike in sanitary and social circumstances, the diarrhœal rate is proportionate to the height of the thermometer, particularly during the third quarter."

During the third quarter of the year 1901, the total deaths in England and Wales, from diarrhœa alone, was 23,941; this exceeds the average for the corresponding quarters during the last ten years. It was found that the temperature during the third quarter of 1901 was 1.9°F. higher than the mean of the corresponding quarters of the preceding ten years.

Dr. Hope, Medical Officer of Health for Liverpool, in his Annual Report for 1904, shows that the same intimate relation exists ^{between} high diarrhœal death-rate and the mean atmospheric temperature during the third quarter of the year.

Seibert, of New York City, has investigated this subject carefully; and, from a number of charts, clearly shows the intimate connection between the temperature of the air, in several of the large cities of America, and the prevalence of summer diarrhœa. Baginsky (Berlin) and Mernent (Dresden) have also prepared charts showing the same connection. These charts all show what we have already pointed out with regard to our own country, viz., a slight rise in the mortality curve during May and June, an enormous rise in July, a gradual decline in August, and a still greater fall in September and October.

Extended investigations go to show that a certain temperature of the air is necessary before any marked increase of summer diarrhœa occurs; and, further, that it is only after the temperature has reached to, and remained above, this critical point for several days that the mortality curve from summer diarrhœa assumes an epidemic form, this critical tem-

etature being generally believed to be somewhere near 70°F. A considerable rise of the temperature of the air above this point is not followed by a proportionate increase in the diarrhœal death-rate; ^{but} when the temperature drops to 66°F., a decided decline in the diarrhœal death-rate is seen to follow. This decline in the temperature, besides favouring a fall in the death-rate, seems to exercise a beneficial influence upon those already suffering from the disease.

The unusually high death-rate, which we frequently find occurring amongst infants after the temperature has reached 70°F. and remaining so for a week or more, may be explained by the presence, in very large communities, of a certain number of infants with very weakly constitutions, the same being susceptible to the first disease that comes their way. The first spell of hot weather appears sufficient to produce a depression of the digestive functions, and, as a result of the heat, thirst is experienced also from the increased perspiration. This leads to an increased ingestion of milk, which in the case of hand-fed infants may be highly contaminated with bacteria and their products; which, combined with faulty assimilation, is followed by diarrhœa in the manner already described.

Another explanation of the apparent relationship between the height of the thermometer and diarrhœa may be afforded by assuming that a certain temperature is necessary before active growth and multiplication of micro-organisms can occur in such foods as milk; and that when such temperature has been reached, any further rise in the thermometer is not followed by a proportionate increase in the growth of the germs in question. For, from what we already know of the bacteriology of this subject, we are not justified in concluding that heat, per se, is more than an indirect agent in the production of diarrhœa, - it favours bacterial growth, and has a markedly depressing effect upon the digestive functions of young children.

SOIL TEMPERATURE AND ITS RELATION TO DIARRHOEA.

Ballard, who has made careful study of this subject, finds a very close relationship between the temperature of the soil, at a depth of four feet, and the mortality curve from summer diarrhœa, but his conclusions do not agree with those of Siebert and Baginsky. Ballard's well-known observations,

made at Leicester, go to prove that there is a somewhat intimate relationship between the occurrence of diarrhœa, in an epidemic form, and the rise of the 4 ft. earth thermometer to 56°F. , and that this relationship is independent of that recorded by the ^{air} ~~earth~~ thermometer, any fall ^{of the 4 ft. earth thermometer} below 56°F. being found to be followed by a corresponding decline in the number of cases of diarrhœa.

Tompkins has carried out a number of experiments with the 1 ft. earth thermometer, and finds that there is an intimate connection between the temperature of the earth at this depth and the mortality from diarrhœa. This temperature for the ¹⁶ ~~1~~ ft. earth thermometer would appear to be somewhere about 60°F.

My own observations, whilst not actually confirming those of Ballard, convince me that the earth thermometer, at a depth of 4 ft., serves as a more reliable guide than the state of the atmospheric thermometer in foretelling the onset of an epidemic of summer diarrhœa. On the whole, I am more inclined to agree with the conclusions arrived at by Tompkins. I regard, in the majority of cases, the 1 ft. earth thermometer as a more delicate and earlier index of the onset of summer diarrhœa than the 4 ft. instrument. In damp clay soil, I have found the 4 ft. earth thermometer failed to record a temperature above 54°F. , - although epidemic diarrhœa was raging, and had been so for over a week, - whilst the 1 ft. earth thermometer recorded a temperature of 60°F. as the mean for the preceding two weeks.

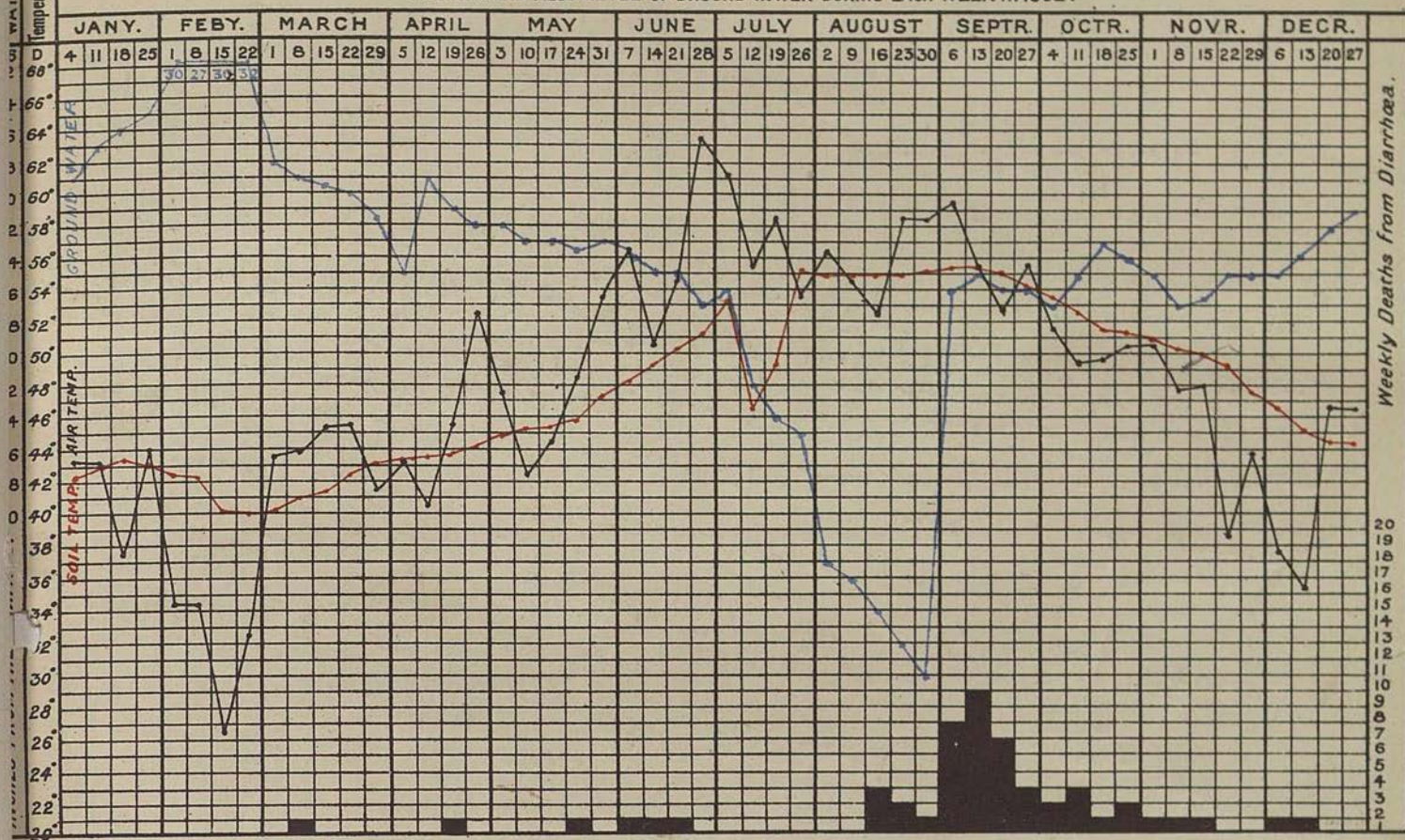
In loose porous soil the 4 ft. earth thermometer, as a rule, gives a better guide, as to the possible prevalence of summer diarrhœa, than does the 1 ft. earth thermometer; the 1 ft. earth thermometer is more subject to the influences of evaporation and barometric pressure than is the 4 ft. instrument.

To be of any practical utility, and to serve as a warning of the onset of epidemic diarrhœa, simultaneous observations ought to be made of the temperature of the atmosphere, barometric pressure, height of the subsoil water, and the temperature of the earth at a depth of 4 ft. If these facts were graphically recorded on a chart, together with the mortality curve in epidemic diarrhœa, we will ^{often} find that the latter only begins to rise after a sudden drop in the height of the subsoil water, which fall is frequently found to be coincident with a rise in the temperature of the air. In

many cases it is found that ^{when} the subsoil water is low and the

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CHART SHewing RELATIONSHIP BETWEEN CASES OF DIARRHŒA AND THE MEAN TEMPERATURE OF THE SOIL AT 4 FEET AND OF THE AIR AND ALSO LEVEL OF GROUND WATER DURING EACH WEEK IN 1902.



soil porous; the 4 ft. earth thermometer will have registered a temperature of 55° to 57°F. for a few days preceding the outbreak of diarrhœa. This is shown in the accompanying chart;—
 the observations made ~~with a view to deciding~~ ^{in the preparation of which} it were found to agree roughly with similar data obtained in eight other separate ~~instances~~ ^{inquiries}, and ~~generally~~ ^{which} illustrate the general meteorological and telluric phenomena associated with an epidemic of summer diarrhœa occurring in one of our large manufacturing towns.

Much the same explanation may be offered with regard to the relationship between the soil temperature and the diarrhœal curve as was given in the case of the atmospheric temperature and the prevalence of diarrhœa; it simply means that the height of the 1 ft. or 4 ft. earth thermometers serve as indices of bacterial growth, and the depressing effects of heat on the digestive and nervous systems of infants.

The earth thermometers are only valuable as a measure of the culminative effect of the solar heat. The earth, having a higher specific heat than the air, renders the earth thermometers less liable to fluctuations. It is very probable that many forms of bacteria lead a saprophytic existence in the superficial layers of the soil; and, when the latter becomes dry and warm, the vital activities of ^{these} bacteria begin to manifest themselves, — being carried about on dust particles, and getting blown into food and drink; and, owing to the increased temperature, of these articles of diet, become most excellent media for the further growth and increased toxicity of many forms which were hitherto harmless.

Ballard thinks that this specific cause of summer diarrhœa resides in the superficial layers of the soil, and only requires a certain temperature to enable it to develop; this specific cause he believes to be intimately associated with the life cycle of some micro-organism; not yet detected, captured, or isolated. He sums up the result of his conclusions thus:

"(a) That the vital manifestation of such micro-organisms are dependent, among other things, perhaps principally, upon the condition of the season and upon the presence of dead organic matter which is its pabulum. (b) That on occasions such micro-organism is capable of getting abroad from its primary habitat the soil, and, having become air-borne, obtains an opportunity for fastening on living organic material, and of using such organic material as a nidus and as a pabulum in undergoing various phases in its life history. (c) That in

food, inside as well as outside the human body, such micro-organism finds, especially at certain seasons, a nidus and pabulum convenient for its development, multiplication, and evolution. (d) That from food, as also from contaminated organic matter of particular soil, such micro-organisms can manufacture by the chemical changes wrought therein through certain of their life processes, a substance which is a virulent chemical poison. (e) That this chemical substance is, in the human body, the material cause of epidemic diarrhœa!"

From the investigations of Hilton, and other workers on this subject, it appears that the soil bacteria are confined to the upper layers. If this be so, one would naturally suppose that their vital manifestations would be best ascertained by the 1 ft. earth thermometer, so that, if we regard the height of the earth thermometer merely as an index of the possible vital manifestations of bacteria, then I think that the 1 ft. earth thermometer furnishes us with a better guide than the 4 ft. instrument. As we have already seen, the only micro-organism isolated from diarrhœal stools, and capable of leading a saprophytic existence, is the bacillus enteritidis sporogenes of Klein; and, on ^{the} hypothesis of Ballard, this is the most likely organism concerned in the production of diarrhœa.

Dr. A. Johannsen points out that the infantile mortality for Norway is lower than that for any other country in Europe, the average being 95 per 1000 births; this he attributes to the fact that there is no rise in the mortality during the summer from diarrhœa.

In some tropical climates the rate may rise to 400 to 600 per 1000 births; this surely affords some evidence of the association between temperature and infantile mortality.

BAROMETRIC PRESSURE.

There appears to be no connection between the amount of moisture present in the air, and the prevalence of diarrhœa.

The observations of Hirsch, made at Berlin, extended over a period of five years, where he records the dew point during June and July, and compares it with the number of deaths from summer diarrhœa occurring during the same months, but fails to find any definite relationship between the two classes of phenomena.

Newsholm, on the other hand, believes that there exists

an inverse ratio between the amount of rainfall and the number of cases of diarrhœa. This may be explained by assuming that the rainfall allays dust particles on which germs and their spores might be conveyed to articles of food and drink; it also possesses a beneficial effect in cooling the air. Meissner and Makenna believe that cholera infantum, as well as other forms of epidemic diarrhœa, are more frequent the drier the atmosphere and the less the rainfall when the temperature is high.

Stewart, of New York, and Lindsley, of Washington, regard a high degree of atmospheric moisture as of great importance in determining the onset of diarrhœa.

The following table shows the result of some observations, made with the object of determining the connection which exists between the atmospheric and telluric states, and the death-rate from diarrhœa:

Week ending	Barometer in inches	Mean temp.	Mean soil temp. at 4 ft.	Rainfall in inches.	No. of deaths from diarrhœa.	Force of wind in miles per hr.
June 7th.	29.766	71.2	48.5	.30	0	40
" 14.	29.511	58.2	49.7	.42	0	31
" 21.	29.651	67.0	50.5	.69	1	34
" 28.	30.028	81.0	51.2	.11	2	27
July 5th.	29.928	84.0	53.4	.24	0	26
" 12.	29.844	75.0	46.9	.53	0	41
" 19.	29.898	73.0	49.7	.08	0	30
" 26.	29.698	60.3	55.1	1.13	0	37
August 2d.	29.842	68.5	55.0	.38	1	39
" 9th.	29.715	64.5	55.0	1.21	2	32
" 16.	29.852	67.8	55.0	.60	1	36
" 23d.	29.625	71.2	55.0	1.06	0	32
" 30th.	29.704	68.8	55.2	.22	1	23
Sept. 6th.	29.610	70.5	55.8	.05	6	51
" 13.	29.854	71.8	55.8	.51	14	39
" 20.	29.784	63.2	55.3	.58	5	45
" 27.	30.000	69.0	54.6	.69	1	27
Mean for the year.	29.740	58.3	48.0	.61	.95	59

From the above table it will be seen that, although the week ending September 6th shows the lowest barometric pressure, with one exception; and also the lowest rainfall in inches for any week during the 17 weeks ending September 27th, -these

two phenomena are followed by the highest number of deaths, for the same period, from summer diarrhœa. This table further supports the conclusions of Ballard, namely, that the summer diarrhœa becomes most prevalent when the soil temperature reaches its maximum degree of warmth, and that the heating of the soil goes on more slowly, and is not subject to the same fluctuations as the temperature of the air.

From a study of the meteorological reports for the last 35 years, I am led to the conclusion that there is no constant and definite relationship existing between the severity of summer diarrhœa and the amount of moisture present in the atmosphere; whereas, on the other hand, there is every evidence that a close and distinct relationship exists, during the third quarter of the year, between the mean temperature and rainfall, and the incidence of summer diarrhœa.

SOIL AND ITS RELATIONSHIP TO DIARRHOEA.

Much of this depends on the nature of the soil, the amount of moisture it contains, and the presence or absence of organic matter. As a general rule, the more porous soils, - such as sandy loam and fine gravel, which are capable of containing in their interstices moisture, - are those most frequently associated with serious epidemics of diarrhœa. Towns built upon solid rock or impervious clay, as a rule, show less incidence to the disease, but this is frequently discounted by the ~~fact of the yards~~ and streets being badly made, or ^{by} the accumulation of vegetable or animal refuse in or about the houses.

The diarrhœal death-rate is more dependent upon the porosity of the soil than upon geographical configuration or height above the sea-level. Given a densely populated, low-lying, porous soil, grossly polluted by organic matter, ^{and} we have, other things being equal, the heaviest death-rate from diarrhœa. Bacteria feed on the dead organic matter in the soil, which they decompose into simpler chemical bodies, some of which escape as gases or other effluvia, which have an injurious effect upon those inhaling them. Food-stuffs like milk, when exposed to such contamination, very readily absorb them, thereby becoming altered in composition, whereby they are capable of giving rise to various gastro-intestinal disorders, or to a lowered state of physical and nervous vitality.

It does not appear that a very dry soil is favourable

to the occurrence of diarrhœa. The higher portions of towns show, as a rule, a smaller death-rate than the lower portions. Possibly this is due to the fact that bacteria not only require a certain amount of heat, but that they also require a certain amount of moisture for their vital manifestations. Excessive moisture of soil, on the other hand, appears to check the spread of diarrhœa, possibly because the water excludes air from the soil and so prevents the upper layers of the earth from becoming dried, and consequently blown about by the wind. In addition to this, it keeps the soil cold, from the constant evaporation which is going on into the air above. This cooling of the air and soil has a very modifying effect on the virulence and spread of the disease; and, as was pointed out by Potter over seven years ago, exercises a beneficial effect on those suffering from the disease.

THE HEIGHT OF THE SUBSOIL WATER AND ITS FLUCTUATIONS.

The amount of water present in the soil depends upon (1) the geographical configuration, (2) the rainfall, (3) the nature of the soil, and (4) the proximity of rivers, lakes, and wells. If the subsoil water is high it excludes air, keeps the soil moist and cold, and, as already pointed out, thereby retards putrefactive changes. The surface soil is constantly being kept moist by capillary attraction and evaporation from the subsoil water.

The observations of Hirsch, made at Berlin, show no direct relationship between the height of the subsoil water and the prevalence of diarrhœa; whilst the observations carried on in this country, indicate for the most part an inverse ratio between the number of cases of diarrhœa and the height of the subsoil water.

The experiments of Rettenköfer, conducted at Munich, on the relationship between the prevalence of cholera and the height of the ground water, showed that when the latter rapidly fell after it had been unusually high, cholera was found to be most prevalent. This he attributed to the surface washings finding their way into the wells and springs from which the inhabitants drew their drinking water; the subsidence of the ground water left the superficial layers of the soil moist and well aerated, - conditions which, when accompanied by heat, are essential to the growth of the cholera vibrio.

Lewis and Cunningham have repeated Rettenkofer's exper-

iments in India, and in the main they arrive at the same conclusions.

Buhl considers that there is an inverse ratio between the height of the ground water and the prevalence of enteric fever in Germany, - the outbreaks occurring in an epidemic form when the ground water was lowest, more especially when it fell rapidly after having attained an unusual height.

On the other hand, however, Feder says that "at Budapest the rise of enteric fever mortality accompanied the rise in the ground water and both fell together." This he explains by saying that "the rising ground water forces the foul air out of the upper layers of the soil, and that such foul air is drawn into the basements of houses, owing to defective flooring and the aspirating action of fires." In each case the presence of a specific germ in the organically polluted soil is assumed.

Robertson and Martin, and more recently Notter and Firth, have shown that the bacillus typhosus can live and retain its pathogenic properties for several months in polluted soil, even in winter.

The bearing of these investigations, as to the probable connection between diarrhœa and the level of the ground water, are far from conclusive. The whole matter, indeed, is wrapped in considerable obscurity; and, until the specific cause of this disease has been isolated, we cannot do more than state the results as already given. The analogy drawn from cholera, typhoid, and dysentery - diseases possessing many of the same characteristics and clinical symptoms as diarrhœa - would appear to justify the conclusion that a high level of the ground water retards the spread of diarrhœa.

LOCALITY.

This is essentially an urban disease, and one which appears to follow civilisation. We are told that it first made its appearance amongst the early settlers along the Atlantic sea-board; and, as the population aggregated into towns, it spread to the Central and Southern States.

The same thing has been seen both in this country and upon the Continent of Europe. During the last 30 years the urban population of this country has greatly increased, with a corresponding increase in the death-rate from summer diarrhœa. In many of the large manufacturing towns of England

- e.g., Preston, Leicester, Manchester, and Liverpool - the disease appears to be endemic; and, in spite of manifest improvements in sanitation, continues, year after year, to cause an exceptionally high death-rate from diarrhœa, when compared with many other towns of the same population.

The following table shows the distribution of this disease in England and Wales, and in the large towns compared with that for the rest of the country:

Comparison between Urban and Rural Mortality from Diarrhœa per 1000 living at all Ages.			
1904	Diarrhœa.	Infantile Mty.	Birth-rate.
England and Wales.	.66	142	32.3
28 large towns.	.89	162	34.0
50 chief towns.	.73	153	33.2
78 urban towns.	.85	160	32.1
Rural (rest of country)	.52	127	30.2

In most of our large industrial towns, it exceeds unity per 1000 living at all ages, and in some of the Northern and Midland towns it reaches as high as 1.5, this being three times higher than that for rural England. Speaking generally, diarrhœa appears to be the expression of the summer heat of towns, just as pneumonia and bronchitis are the expression of winter cold. The aggregation of people in the poorer quarters of our large towns, - where filth, absence of ventilation, and concomitant ignorance and poverty exist, - must serve as powerful factors in the propagation of any infectious disease.

The scarcity of water during the summer months has, in some of the towns above-mentioned, been held responsible for the high death-rate from diarrhœa. The employment of female labour, so extensive throughout Lancashire and Yorkshire, is no doubt responsible for much parental neglect and improper feeding, which are certainly important predisposing causes of this disease.
summer diarrhœa.

Intemperance and immorality are also more prevalent amongst the dwellers in towns, and are associated with a high infantile mortality, as well as, one may ^{also} conclude, an increase in the death-rate from summer diarrhœa. To illustrate this point the case of Manchester may be cited. Here we find that the district of Cheitham has the lowest infantile mortality for any division of the city, as, too, the smallest number of illegitimate births. This district is chiefly inhabited by Jews, who are noted for their sobriety and morality, and who,

as a rule, work at home. For the whole of Manchester the death-rate amongst illegitimate children is 46 per 100 births under one year of age. The same condition is found in the large towns of America and France, where about half of the illegitimate children die before they attain the age of twelve months.

INFLUENCE OF AGE AND SEX.

This is essentially a disease of tender age. About 63 per cent. of the total deaths are confined to children under one year of age, and no less than 80 per cent. to those under 2 years of age. During the first three months of life relatively few deaths occur from it, as the following table, given by Holt and concerning his own patients at the North Western Dispensary, New York, will show:

Ages.	Number of Cases.	Ages.	Number of Cases.
1 - 6 months.	119	18-24 months.	125
6 - 12 "	257	Over 2 years.	142
12- 18 "	149	Total no. cases.	772

In general, these figures agree with the more recently collected statistics for this country and Germany. Of the 1,460 cases I have seen in England, within the past five years, the ages were as follows:

Ages	Number of Cases.	Ages.	Number of Cases.
0-3 months.	97	12-15 months.	211
3-6 "	134	15-18 "	221
6-9 "	273	18-21 "	133
9-12 "	312	21-24 "	79

I have only seen 42 cases of true epidemic diarrhœa in children over two years of age, and of this number 35 were under three years. Thus, of the total number of cases seen, over 96 per cent. occurred in infants under two years of age. This is a somewhat higher percentage than the figures given for England and Wales; and is doubtless due to the fact that most of my cases occurred in the large industrial towns of Lancashire and in the city of Birmingham, and that my patients were chiefly confined to the poorer classes of the inhabitants.

Ballard thinks that the liability to attack is greater from the first up to the beginning of the second year of life; and Tompkins says that "infants and young children form only a small proportion of those attacked, although they furnish nearly the whole of the deaths." He must, however, have been referring to diarrhœa as a generic term, used to indicate a wide variety of conditions of the stomach and intestines, in which diarrhœa was one of the symptoms, and not to the specific forms now under consideration.

Out of the 1,780 deaths from this disease in the city of Liverpool last year, 1,640, or over 97 per cent., occurred in children under two years of age. These figures prove, I think incontestably, that this is a disease which finds its victims amongst those of tender years, and that it is almost wholly confined to infants of two years of age and under.

With regard to sex, the available statistics show that this disease exercises little selective tendency, both males and females suffering from it alike. The death-rate also does not appear to have a higher incidence on the one sex or the other, more than is accounted for by the excess of male births over females, and the higher death-rate generally amongst ~~male children~~ ~~boys~~ during the first five years of life.

In the 1,460 cases which I have recorded, the proportion of male to female attacks was 726 to 714, and the number of deaths 68 to 61.

Finally, Ballard believes that the liability to attack is greatest amongst males at all ages.

THE PART PLAYED BY FLIES IN THE PROPAGATION OF DIARRHOEA.

Many Medical Officers of Health in this country are inclined to consider the presence of the domestic housefly (*Musca domestica*) as a possible factor in the spread of diarrhœa. With a view to determining this point, I have conducted a number of experiments, the results of which have led me to believe that the part played by flies in the propagation of this affection is only of subsidiary importance.

Flies occur in largest numbers during the period of the year when the disease is most rampant, being most numerous wherever filth and other unhygienic circumstances obtain; and they may occasionally become the accidental agents in

~~carrying~~ ^{conveying} the germs of this disease from excrementitious matter to the milk of the infant. Diarrhœa and flies are more dependent upon the accumulation of organic matter, in and around dwellings, than upon each other; and there is just as much evidence, at present, that diarrhœa may be responsible for flies as the latter for the former.

The view has recently been advanced, by some sanitarians in this country, that possibly the micro-organism of diarrhœa may pass part of its life cycle in the body of the fly; but of this there is not a vestige of evidence, and until the bacteriology of this disease has been established, it is useless to regard the presence of the common housefly as anything but the existence of a condition of things favourable to the occurrence of diarrhœa.

THE EFFECTS OF IMPROPER FEEDING.

The natural food of children under one year of age is milk; and, owing to the deplorable fact that so many mothers are either unable or unwilling to perform their duty of suckling their infants, cow's milk has become the food basis for a large and growing number of the infants in this country.

Owing to the way in which it is collected and distributed, impurities of all kinds find their way into milk; which, during the warm weather, are apt to give rise to symptoms of gastro-intestinal disorders, which we have already seen to precede a large number of the cases of summer diarrhœa.

Human milk is practically a sterile fluid, a perfect aliment, and, as such, should constitute the sole nourishment of the infant until it has reached the age of eight or nine months. No artificial food, however carefully prepared, can take its place as a food for the infant, and for this reason every opportunity should be taken to induce mothers, physically fit, to suckle their infants; for it is not so much a question of what a child will take as what it can digest, which determines its physical and mental development.

Nothing has been more incontestably proved than the fact that artificial feeding of infants constitutes one of the most powerful predisposing causes of epidemic diarrhœa. Of the 1,460 cases of summer diarrhœa which I have personally examined, 813, or 81.3 per cent., were hand-fed infants, and of this number 623 were fed on cow's milk alone, the remaining

190 receiving either condensed milk or other patent foods.

Dr. Newsholm, in his Annual Report for 1903, shows that infants fed wholly on either cow's milk or condensed milk suffer ^{more} from summer diarrhœa, and breast-fed infants least. He ^{conclude} concludes, moreover, that "the deaths of suckled children were ^{only} one-ninth of what ought to have occurred on the supposition of the average distribution of diarrhœa; the deaths of those suckled and having also farinaceous food were about one-third; the deaths of those having only cow's milk were three times; ^{and} the deaths of those having condensed milk about seventeen times the number that ought to have occurred, on the supposition of average distribution of diarrhœa amongst infants, fed in different ways. If we assume that feeding plays no part in the causation of diarrhœa, these differences are difficult to explain; if, as is practically certain, it plays an important part, then suckling is a very potent means of minimising its incidence. The use of cow's milk under present conditions greatly increases its incidence, and the use of condensed milk further increases its incidence".

Dr. Hope has shown that, for the city of Liverpool, the death-rate amongst infants, who are either wholly or partially fed on artificial food, is fifteen times as great as it is amongst an equal number of infants fed on the breast; the same facts are brought out in ^{the} investigations for other large cities in this country and France.

P. Burdin, in his Report to the Commission on the Depopulation in France, shows that out of 134,434 infants dying in France, 68.2 per cent. resulted from diarrhœa alone, and this he attributes to the prevalence of artificial feeding, so common in that country. Out of every 100 deaths in France, 88 per cent. occurred in hand-fed infants; the few deaths occurring in breast-fed infants were, in his opinion, the result of excessive or irregular feeding during the warm weather, when less food is required by the infant, and the excessive high death-rate amongst infants to similar causes - plus adulteration, bacterial contamination, and the absence of cream from the milk consumed.

Ireland has a much lower death-rate from summer diarrhœa than England and Wales; and this is doubtless due to the larger number of its inhabitants living under rural conditions, but also, I believe, to the fact that a larger percentage of Irish than of English mothers suckle their infants.

The three chief factors which contribute to the occur-

ence of a higher death-rate amongst hand-fed infants, compared with those fed on the breast, are: (1) the chemical and physical composition of the food; (2) bacterial and organic contamination of milk; and (3) ignorance as to the proper methods of preparing food, and of giving it to the infants. In this country cow's milk forms the chief substitute for breast milk. It varies considerably in composition, but always contains a larger percentage of albuminoid material than human milk; it is poorer in sugar, and, as a rule, richer in salts than healthy breast milk.

(1) Cow's milk, when it reaches the consumer, is either neutral or slightly acid in reaction, from the presence of lactic acid, - a product of bacterial activity, - whilst human milk is always either alkaline or faintly neutral.

The following table, after Richmond, gives the average composition of breast milk, and that from healthy cows:

<u>Constituents.</u>	<u>Human Milk.</u>	<u>Cow's Milk.</u>
Fats	3.5	3.76
Sugar	6.8	4.75
Proteid	1.5	3.51
Salt278
Water	88.2	87.20
	<u>100.00</u>	<u>100.00</u>

From the above table it will be seen that the proteids in cow's milk are, on the average, more than twice the quantities found in human milk. It is the difficulty attending the digestion of this large percentage of proteid matter which gives rise to so much trouble when cow's milk is employed, in the undiluted form, for the food of infants. The proteids of cow's milk, besides being in excessive quantities, are far more difficult to digest, owing to the large amount of insoluble casein present, and the tendency of the latter to form dense masses in the infant's stomach. Human milk, on the other hand, contains a relatively small amount of proteid material, the casein of which forms light flocculi in the stomach, which are easily acted upon by the gastric juices.

(2) The number of micro-organisms found in cow's milk depends upon the season of the year, the care with which the milk is collected and delivered, and the age of the milk.

Notter and Firth have found as many as 400,000 per c.c.

in ordinary cow's milk, amongst which they were able to identify the bacillus lactis aërogenes, the bacillus butyricus, the bacillus mesentericus vulgaris, the bacillus subtilus, and the bacillus coli communis, together with several other forms of bacteria and cocci. Of 370 samples of milk, arriving from places outside Liverpool for distribution in that city, no less than 118 were found to contain the bacillus coli communis, and 35 the bacillus enteritidis sporogenes; whereas the bacillus coli communis was only present in 22 samples, and the bacillus enteritidis sporogenes in 8, out of the 201 samples of city-produced milk examined. These figures, contrary to what is usually held, show that it is not the locally produced milk of large cities which is richest in bacteria, but the milk collected and brought from a distance, where sanitary supervision over the dairies and cowsheds is absent or indifferently administered.

It is the realisation of facts like these that constitutes the strongest argument for extending the provisions of the Dairy and Cowshed and Milkshops Order, so as to embrace those places outside municipal boundaries from which they derive their milk supply.

There is already abundant proof that milk, as usually sold in this country, is the agent by which such diseases as enteric fever, diphtheria, and scarlatina are sometimes propagated. Evidence is now accumulating that it plays no less a rôle in the spread of diarrhœa; for, by reason of the extensive use of it as a food for hand-fed infants, and from the rapidity with which it undergoes putrefactive changes, as the result of bacterial growth, - it constitutes a grave source of danger to the infantile population of this country - either by conveying the specific cause of epidemic diarrhœa to the infant's stomach, or by causing dyspepsia or other catarrhal disorders of the gastro-intestinal tract, which, as we have already seen, predispose in a very marked degree to this disease.

No better proof can be afforded of the injurious effect in infants from the ingestion of germ-laden milk, than the results which have followed the introduction of sterilised milk depots; the mortality from diarrhœa has been reduced by 50 per cent., both in this country and in France, from the use of sterilised milk. Many other substances besides bacteria find their way into milk, some accidentally, others by wilful addition. The former, for the most part, consists of organic

matter, derived either from the cow or the hands of the persons who handle the milk, - all of which cause a deterioration in the milk and an alteration in its chemical composition, and also constitutes a source of grave danger to the infants who ingest it.

(3) Ignorance and carelessness in the preparation of infant food and the too frequent feeding of infants, have been shown to result in an impairment of gastric digestion. This is specially apt to occur during the warm weather, when the thirst of the infant demands a greater amount of fluids, and a less amount of food. Unfortunately, however, both the food and drink of the infant consist of milk alone, and this is administered when only the latter is required by the system; and, owing to the depression of the digestive functions from the excessive heat, dyspepsia is likely to result from overfeeding. The common habit, seen too frequently amongst the poor, of filling a large bottle with milk, and placing it beside the infant, cannot be too strongly condemned, inasmuch as it constitutes one of the gravest dangers connected with the artificial feeding of infants.

DENTITION.

There can be no doubt, in spite of much that has been said to the contrary, that dentition predisposes children over the age of six months to gastro-intestinal disorders, especially during the summer months when the digestive powers are at their lowest. Diarrhœa is most prevalent at those ages when the eruption of the milk teeth occurs; and one may frequently see the same children cutting their teeth in summer with a slight attack of diarrhœa, whilst at other seasons bronchial catarrh appears to replace the diarrhœa. These two phenomena would appear to be due to reflex irritation consequent on dentition; nor is this to be wondered at when we recollect the extremely sensitive nature of young children's nervous system, and how readily it responds to peripheral irritation. We do not for a moment regard dentition alone as more than a predisposing cause of this disease, interfering with digestion, and so providing a fertile soil for the implantation of pathogenic micro-organisms.

EXPOSURE TO COLD.

It would seem somewhat a contradiction of terms to regard

summer diarrhœa as possibly due to exposure to cold; nevertheless, I believe that the exposure of infants to sudden chills may sometimes end in attacks of diarrhœa, by causing venous congestion of the internal organs, thus impairing digestion.

The heat-regulating mechanism of infants is very easily disturbed by slight colds, and also by indiscretions in diet. Infants lose heat more rapidly than do adults. In proportion to their weight, their body surface is great, and the unequal distribution of heat, consequent upon the custom of overclothing the thorax and abdomen, produces congestion of the stomach and lungs, and so impedes digestion and respiration.

I have noticed that, both in private and dispensary practice, a larger number of cases of diarrhœa and bronchial catarrh are brought for advice during the first three days of the week than the last; and the results of my enquiries lead me to believe that this is due to the drunken bouts of parents at the week end, with consequent neglect and exposure to cold.

The large number of infants one sees out at night in the busy thoroughfares of our large towns, improperly clothed, and carried about in the cold night air after a warm sultry day, must be detrimental to their health, especially in rickety children or those suffering from catarrhal conditions of the lungs or bowels.

MORBID ANATOMY AND PATHOLOGY.

STOMACH AND INTESTINES.

It will only be necessary to briefly review the few morbid changes found after death in this disease; everything said under this head, when speaking of simple diarrhœa, applies with equal force here.

The few opportunities afforded for performing autopsies on cases dying from this disease, reveal the great disparity there exists between what is seen in the intestines after death and the clinical symptoms occurring during life. Many of the cases, exhibiting the severest symptoms, after death present scarcely any morbid lesions, either in the stomach, the intestines, or the internal organs.

In judging of the degree of the structural alterations, one must exclude the possibility of regarding the post-mortem findings, ^{as} having actually occurred during life. It is always desirable in conducting autopsies on cases of this disease to do so as soon as possible after death, for both the intestines and the rest of the abdominal contents are apt to very rapidly undergo post-mortem changes, - especially in children during warm weather, - which are very apt to be mistaken for antimortem conditions.

Macroscopic lesions may be absent, or limited to slight catarrhal inflammation of the large intestine; but here and there there may be some desquamation of the superficial epithelium or partial hyperæmia - usually best seen in the solitary glands, or in the Peyer's patches, of the large gut. Occasionally one may find some swelling or induration of the mesenteric glands, but this is more common in old-standing cases, or where ulceration of the mucous membrane of the bowels has occurred. Very rarely do we come across any extensive ulcerative lesions in the intestines, except in very chronic cases, or in those presenting the type of colitis or dysenteric diarrhœa.

The above-mentioned changes are usually confined to the large intestine and the lower two-thirds of the ileum; it is a very rare experience to encounter more than a mild catarrhal condition existing in the stomach and duodenum. One case of cholera infantum, where I was able to perform an autopsy within seven hours after death, presented ^{an} intensely inflamed

state of the lining membrane of the stomach, with one or two small hæmorrhages. Nothing was seen on microscopical examination, however, beyond a variable degree of infiltration of the mucous and submucous membranes. It is very rare to find bacteria invading the coats of the bowels, unless there be some necrotic or ulcerative change in their mucous membranes.

Lesions in Other Organs.

LUNGS.

According to Holt, broncho-pneumonia is by far the most frequent lesion found in the lungs of infants dying from summer diarrhœa; and this is just what we would expect from the symptoms seen during life.

Of 70 cases seen by Holt ~~two~~ presented appearances of broncho-pneumonia, the type of the disease was subacute, and in a few cases slight hypostatic congestion was observed.

Some authors have described cases in which gangrene or collapse of the lungs were observed, but in the vast majority very few pathological changes were seen in the pulmonary tissue at the autopsies.

Lesage has obtained pure cultures of the bacillus coli communis from the consolidated patches of pneumonia, but such cases must be extremely rare.

KIDNEYS.

The only constant change which has been observed is a slight cloudy swelling of the renal epithelium in the convoluted tubules: this is only specially noticed in cases which have had a high temperature, and appears to be nothing more than what is observed in all acute febrile diseases generally.

Of the 70 cases examined by Holt, only one presented well-marked appearances of nephritis.

I have found slight enlargement of one kidney, with ~~a little~~ ~~slight~~ adhesions of the capsule over the anterior and upper surface of the organ: this was a well-marked case of albuminuria, with a considerable diminution of the urine during life.

Many authorities, Kjelberg included, describe a parenchymatous nephritis in infants dying from this disease; but such cases are now believed to be very rare, the lesion in question being more of the nature of a complication than an accompaniment of this disease.

SPLEEN.

This organ is usually slightly congested, darker in colour, and of softer consistency than normal. The Malpighian tufts are enlarged, or engorged with leucocytes, some of which show proliferative changes.

No constant changes are to be found in connection with the HEART, the LIVER, or the PERITONEUM, which are of any special importance.

BRAIN.

From the frequency with which cerebral symptoms occur during the course of cases of diarrhœa, one might expect to find some evidence of distinct cerebral changes, especially in those infants dying from what has been described as the encephaloid type of this disease; but here, just as in the case of the alimentary tract, one is struck by the want of parallelism between the changes seen after death and the severity of the symptoms presented during life.

Congestion of the brain has been found in some of those cases dying after convulsions, but not in all. An increase of cerebro-spinal fluid is of fairly constant occurrence, in cases quickly ending in death, but it appears to be of little or no significance.

In one of the cases I examined, there was a small thrombosis of the left lateral sinus, and an increase of fluid in both ventricles. This case presenting marked cerebral symptoms for five days preceding death, I was much surprised not to find evidence of basal meningitis, as the infant presented well-marked clinical symptoms of this condition before death; the cerebral cortex and the cerebral meninges were pale and rather dry. I inoculated tubes of agar, both with the fluid from the ventricles and the lateral sinus, but failed to obtain any growth.

Holt believes that anæmia of the brain is responsible for the cerebral symptoms seen during life; but I am rather inclined to refer these symptoms to the circulation of toxins in the blood and their ultimate fixation in the nerve cells.

S Y M P T O M S.

The disease under consideration may arise suddenly in infants previously healthy, but it is more usual for it to come on gradually, or follow an attack of simple dyspepsia or other disordered state of the digestion. In healthy infants, usually the first thing to be noticed is a restlessness on the part of the patient; its sleep is short and disturbed at night; the hitherto placid features give place to a fretful and troubled expression, which the mother is inclined to set down to some trifling nervous disturbance, such as teething. The appetite, at first good, becomes capricious and is ultimately lost, and what little food is taken is often rejected forthwith. From the first thirst is a constant symptom, and very often the avidity shown for liquids leads the mother to believe that it is hunger that the child is suffering from. The tongue, at first clean, gradually becomes coated with a slight fur. The temperature is slightly elevated from the first, and may rise to 103°F , or a degree higher, within the first few hours.

After an interval of from a few hours to two days after the appearance of the first symptom, diarrhœa occurs, the character of which will depend upon the class of food taken, and the length of ~~the~~ time it has remained in the stomach. As a rule, it mainly consists of partly digested food and milk curd. Its reaction is usually acid, and its expulsion is seldom accompanied by any straining.

Vomiting, as a rule, precedes the onset of diarrhœa, but not always; and, in weak infants, the occurrence of both together very quickly exhausts the remaining strength. The vomited matter at first consists of the rejected food, mixed with mucus; it has a heavy, sour smell, and an acid reaction.

In cases in which the disease comes on gradually, or follows some slight disturbance of the digestive or nervous systems, the infant usually presents symptoms of peevishness, and an irritability of temper which finds expression in fits of crying, the same being rather increased than relieved by the ingestion of food.

Irregular attacks of vomiting may occur from the first,

but usually a few days elapse before it becomes at all severe. It differs from the vomiting seen in the later stages of the disease, in that it is less constant, and ~~is~~^{does} not following the immediate ingestion of food.

Diarrhœa is not a characteristic feature of these cases. During the first day or so, of the illness, the temperature may be normal, but it is usually elevated one or two degrees; the appetite is somewhat diminished, but not lost; and anorexia is never so pronounced as in the cases beginning suddenly.

In both classes of cases vomiting soon becomes well marked, and the taking of food or drink appears to excite the act; at first it may be the rejected portion of food, but afterwards it consists of mucus alone: it is seldom blood stained.

The stools at first are thin and flocculent, of a greyish or greenish colour, and very offensive, neutral, or faintly acid; but, after the first storm of diarrhœa, they become clear, without any admixture of flocculent matter, and consist mainly of mucus and blood-serum, with an alkaline reaction, and devoid of offensiveness.

There does not appear to be much pain associated with the diarrhœa; and tenesmus, in the earlier stages at least, is absent. There appears to be a relaxation of the anal sphincters early in the disease, due probably to a paralysis of the reflex centres in the spinal cord.

The abdomen is distended at first, but palpation fails to elicit much tenderness or gurgling. The passing of flatus during the early stages is quite common, especially in the case of infants fed on starchy foods or condensed milk.

The number of stools is subject to great variation, and may range from five to twenty, or more, in the twenty-four hours.

The temperature may sometimes drop one or two degrees after the first storm of diarrhœa has passed; but, if milk or any other article of food be given, the temperature rises again and the vomiting, which may have been in abeyance, returns.

With the progress of the disease, all the subjective and objective symptoms become more marked; the infant whines and cries day and night, sleeping only in short snatches, or not at all. Sometimes, when the progress of the disease is very rapid or the infant much weakened in health from former illness, stupor may occur early in the course of the affection.

The pallor of the skin and mucous membranes,- which may have been present from the first,- becomes more pronounced. The former loses its elasticity, and may hang in folds about the trunk and limbs; the weight and strength are rapidly lost; the muscles become soft, flabby, and shrunken from the rapid loss of fluid through the bowels. Indeed, Baginsky records a case where an infant suffering from this disease lost three pounds in two days.

The breath, heavy and foul at first, afterwards becomes hot and dry. The tongue at this stage is covered with a thick ~~green~~ ^{white} or yellow fur; and, if the symptoms assume the character of those seen in typhoid, the tongue may become dry, brown, and clean; ~~and~~ the patient lies with the knees drawn to relieve the pain in the abdomen. Patches of thrush and stomatitis may be seen on the buccal mucous membrane, and upon the roof of the mouth; the gums are swollen and congested; and the teeth, if present, are covered with sordes. The lips are dry, and, especially about the angles of the mouth, ^{fissures are} liable to the occurrence of fissures.

The temperature, elevated from the first, may reach as high as 104°F. in the rectum, and may sometimes assume a remittent type. Some authorities believe that the temperature may become subnormal; but this, at least in my experience is rare, except immediately before death, and only in those cases which progress rapidly to a fatal termination. Infants' temperatures should always be ascertained by placing the bulb of the thermometer well inside the rectum, unless in those cases where this procedure is found to excite straining or defæcation. It is the only reliable method of measuring the heat of the infant's body; and, if it were more frequently employed, one would hear less of the number of cases of subnormal temperature in this disease. Personally, I have only seen five cases of true epidemic diarrhœa in which the temperature was below 98°F. , and all these were cases of infants dying from the choleraic form of the disease, the registrations in question being made immediately before death. It is a difficult matter in many of these shrivelled-up little patients to obtain the close apposition of the folds of skin, in the axilla, necessary to the correct registration of the surface temperature of the body; I have seen as much as 1.8°F. separating the axillary and rectal temperatures.

The pulse is quick, small, and feeble, and, towards the end, it may become very irregular and almost imperceptible.

The facial expression becomes completely altered, the patient having an anxious, pinched expression; the eyes are sunken and surrounded by a dark, bluish ring; the eyelids are half closed; the corneæ are dull and sometimes covered with a mucous film; the pupils are dilated and sluggish; the nose is pinched and pale; the cheeks are sunken; the skin of the body is dry, and of a disky hue; the fontanelles are depressed; and the ears are so thin and bloodless, as to be almost transparent. The skin of the face is drawn into longitudinal folds, and the lower jaw drops from loss of muscular tone.

Restlessness and irritability of the nervous system may give place to depression and collapse. Sometimes convulsive seizures may occur at this period, or a few of the cases may pass into what has been called the spurious encephaloid type, - where the expression is apathetic, and the breathing slow and irregular, often, ~~moreover~~, partaking of the Cheyne-Stokes rhythm; the head is retracted, the pupils unequally dilated and irresponsive to light and accommodation; the eyeballs are turned upwards, and the sclerotic swollen and injected.

During this stage of the disease the child will often take large quantities of food to allay its thirst; the vomiting is usually less alarming, and the diarrhœa less frequent, unless in those cases progressing rapidly to a fatal termination; as a rule, the temperature remains elevated long after the other symptoms have subsided, and, in cases ending in death, it may rise to 105° or 106°F. *just before death.*

In all cases of diarrhœa, as might be expected, the urine is diminished after the first twenty-four or thirty-six hours from the commencement of the illness, and in cases ending rapidly in coma it may be completely suppressed *for* twenty-four hours before death. In 8.7 per cent. of my cases, complete suppression occurred, and in 18.3 per cent. albumin was present in greater or less amount. I have only found blood in the urine of three cases, and sugar in none. The phosphates, urates, and sulphates are increased in amount; the chlorides are diminished; and sometimes tube casts are found in subacute cases.

THE CHRONIC FORM.

This form of the disease usually follows on the acute attack; sometimes it may result from repeated attacks of dyspepsia; and it is more common in infants over two years

of age.

The symptoms are less pronounced, though the temperature may be elevated for only a day or two at a time. But in the vast majority of cases there is little feverishness; the pulse is less rapid and fuller in character; the appetite usually remains normal, or it may be excessive in some cases; the tongue, as a rule, is slightly coated, but the breath is not so heavy and sour as in the acute form of the disease. Vomiting is slight, or only occurs in paroxysms, and is easily controlled; the faeces are voided less frequently, and they are of a firmer consistency, being composed of partly digested food, mucus, pus, and epithelial cells, and sometimes blood. In colour they are of a yellow or yellowish-brown hue, possessing a faeculent odour and acid reaction. Straining is sometimes associated with the act of defaecation, and prolapse of the rectum is not infrequent.

The abdomen is tympanitic, and sometimes tender on percussion; the subcutaneous fat is quickly lost; the skin becomes inelastic, of a dirty earthy hue, and hangs in folds about the body.

The temper is erratic; but, as a rule, the infant is constantly whining, and wants nursing all the time that it is awake.

As the disease progresses the strength becomes rapidly diminished; and, unless energetic means of treatment are adopted, exhaustion, ending in stupor or coma, supervenes, or the infant may pass into a marasmic state from which it ^{seldom} ~~never~~ rallies.

COURSE AND DURATION.

This disease is very irregular in its course, and both intermissions and remissions are frequent. Usually, however, after the first storm of diarrhoea and vomiting, there is an improvement in most of the symptoms. The temperature drops, it may be one to three degrees. There is also an improvement in the nervous symptoms; vomiting becomes diminished or absent; and the number of stools gradually becomes less, - they are also of a firmer consistency, contain less mucus, and in a day or two may appear to be quite normal, both in colour and character. Thirst is diminished, and the appetite quickly returns; the pulse becomes slower and steadier; the infant

sleeps better; strength and weight are rapidly regained; and, in five or six days from the commencement of the illness, convalescence is completely established.

It is more common, however, to find the disease running a far more serious course, and lasting for from ten to fifteen days, especially in hand-fed infants. On the other hand, death is by no means infrequent, especially in the choleraic type of the disease, within the first twenty-four hours of its duration. I have seen many of these cases perish within twelve hours from the onset of the illness; but, in the vast majority of cases ending fatally, the patient lingers on from three to seven days, and death is ushered in with coma or sudden collapse.

Many of the cases which do not receive careful treatment from the beginning take on the chronic type of the disease, which may end in tuberculosis of the intestines, colitis, or dysentery. Some pass into the so-called spurious encephaloid form; more than 40 per cent. of my fatal cases, lasting over nine days, developed this latter condition, and nearly 80 per cent. of these cases ended fatally. This convinces me of the great importance of proper and energetic treatment from the very commencement of the disease; for, once the profound nervous manifestations make their appearance, the case is almost hopeless, owing to the concentration of some powerful toxine acting on the central nervous system.

CHOLERA INFANTUM.

A few remarks are here necessary with regard to that form of the disease called cholera infantum. In my experience it is not very common in this country in infants under two years of age; but, when it does occur, it is characterised by a very high death-rate, most of the cases ending fatally in from eight to thirty-six hours.

The disease usually begins suddenly in pale, weakly, hand-fed infants; and sometimes it may follow exposure to cold or an attack of acute dyspepsia. I believe that this is a very contagious form of diarrhœa: in one instance I saw no less than four infants in the same household seized with this type of diarrhœa.

Within twenty-four hours the vomiting in this form of the disease is very incessant. After the first eight or ten hours of the diarrhœa, the stools contain little feculent

matter. They are almost odourless, very watery, with mucous flocculi floating in them, - the appearance very much resembling the rice-water stools of Asiatic cholera.

Another special feature of this condition is the rapid loss of flesh, and the extreme degree of prostration to which the infant may be reduced within a few hours. The child may be running about in the morning, apparently quite well, and before night be in a state of articulo mortis, with pale shrunken features, cold, clammy skin, thready pulse of 160 to 220 per minute, shallow, irregular, slow respiration, cold breath, suppression of urine, and almost continuous involuntary action of the bowels.

Although the surface temperature of the body may be subnormal, that of the rectum is usually 100° to 103°F. , or over. Either coma or convulsions may occur before death, and sometimes the temperature in the rectum runs up to 105° or 106°F. just before the end.

.....

DIAGNOSIS.

There is seldom any difficulty in distinguishing this disease from the other forms of symptomatic diarrhœa with which it is most likely to be confounded. Epidemic diarrhœa is chiefly confined to the third quarter of the year, and rarely assumes serious proportions until the atmospheric temperature reaches to 68° to 70°F. During the last five years I have only seen thirteen cases after October. It is presumably a disease of early life, and very few cases are seen in children over five years of age; and 86 to 90 per cent. of the cases occur in hand-fed infants.

As many of the acute febrile diseases of infancy, - such as measles, scarlatina, broncho-pneumonia, and enteric fever, - may be ushered in with symptoms somewhat resembling those of diarrhœa, one must be always careful to exclude the possibility of these diseases before arriving at a diagnosis of epidemic diarrhœa. Usually the difficulty is not great, for after twenty-four hours the characteristic rashes and physical signs of the above-mentioned diseases will be experienced, ^{and help to} clear up all doubt.

The greatest difficulty will be experienced in the case of pneumonia and typhoid fever.

In PNEUMONIA, as a rule, the vomiting will subside after the pulmonary symptoms have become pronounced; the temperature is high from the first; and the disease is less prevalent in summer than during the other seasons of the year.

The occurrence of TYPHOID FEVER in infants must not be overlooked. Its differential diagnosis from the disease under consideration is attended with some difficulty, for in infants too much reliance cannot be placed upon the Widal test for typhoid fever. In the few cases where I have used the Widal test, the results were most unsatisfactory; with the greatest care and attention to detail, the same blood-serum was often found to yield contradictory results within twenty-four hours. With children over five years of age, my experience leads me to believe that the test is more reliable. What the explanation of this want of agglutinative action on the part of young infants' blood-serum may be, is difficult to ^{interpret} ~~say~~. I have not seen the phenomenon alluded to by any writer upon the subject.

In general, diarrhœa and vomiting are not such pronounced symptoms of typhoid as they are in the diarrhœa of infants. The presence of rose-coloured spots on the abdomen, the enlargement of the spleen, and the tenderness in the right iliac fossa are features of typhoid fever, which are not seen in cases of epidemic diarrhœa.

The age is no guide, for typhoid fever has been known to occur in infants under three months of age. I have seen nine cases of typhoid under the age of four months. Finally the symptoms of diarrhœa come on suddenly, whereas typhoid fever is of ^{more} gradual invasion.

MENINGITIS may sometimes simulate summer diarrhœa, but the vomiting and characters of the stools are quite distinct in this disease. For the most part, the onset of the symptoms are more gradual, and the loss of weight and strength are seldom so rapid. Meningitis may occur at any season of the year, and is more frequent in infants over three years of age than under.

The difficulty, however, is to distinguish meningitis from the spurious encephaloid form of diarrhœa: here we must be guided by the previous history, the onset of the symptoms, the age of the patient, and the season of the year.

OTHER CONDITIONS which must be borne in mind, in the differential diagnosis of epidemic diarrhœa, besides those already mentioned, are influenza, malaria, tonsillitis, tubercular enteritis, and intussusception. *the diagnoses of which seldom present any difficulty, and consequently only call for passing notice.*

P R O G N O S I S.

This will mainly depend upon the previous health of the infant, the severity of the symptoms, the period of the illness at which the treatment was instituted, as well as the care and skill with which it is carried out.

It is very difficult to give any figures showing the case mortality for this disease, as the data for such are not easy to collect, and often, moreover, owing to the want of uniformity in nomenclature, very unreliable. For my own cases, the figures work out at something like a case mortality of 3 per cent.

The age of the patient is of considerable importance, the death-rate being highest between nine and nineteen months; whilst infants over two years of age show a greater resistance to attack, but, as a rule, are more liable to relapses, and not rarely succumb to some intercurrent disease.

The previous mode of feeding is also of some importance as an aid to prognosis; for, not only are hand-fed infants more liable to the disease, but they die in greater numbers than breast-fed ones; furthermore, relapses and complications are far more frequent in the former than in the latter.

The social and sanitary surroundings of the patients exercise a powerful influence in determining the chances of recovery from the primary disease itself, or from the complications which may occur.

The outlook is usually bad in cases of high temperature, incessant vomiting; and frequent serous stools, mixed with mucus or blood; diminution or suppression of urine, with or without the presence of albumin or tube casts; rapid onset of collapse; loss of weight; and a pale, dry skin.

Much will depend also on the temperature of the atmosphere.

Finally, the prognosis is usually better at the beginning of the epidemic than towards the end when, by reason of the heat of a long summer, the infant's strength and constitution have become seriously impaired.

COMPLICATIONS AND SEQUELAE.

The usual COMPLICATIONS are such as erythema of the buttocks and thighs, caused by the acrid stools and urine. Boils may occur in any part of the body during convalescence, and are usually seen on the face and scalp. Eczema, in my experience, is not at all of infrequent occurrence, and seborrheic dermatitis of the scalp followed in 2.4 per cent. of my cases.

Scleroma has been mentioned by some authorities, as occurring during the convalescent stage, but I have not seen any examples of it.

Catarrhal or follicular stomatitis is, especially in weakly and poorly nourished infants, of frequent occurrence.

Thrush and noma have sometimes been noted, especially in the subacute or chronic form of the disease.

Mention has already been made of the occurrence of broncho-pneumonia, tubercular enteritis, enlargement of the inguinal and mesenteric glands.

Peritonitis and periostitis are of but rare occurrence.

The common SEQUELAE associated with this disease are chronic diarrhœa, colitis, ulceration of the bowel, intussusception, prolapse of the rectum, tubercular peritonitis or enteritis, and otitis media.

T R E A T M E N T.

(B) PROPHY (A) PROPHYLAXIS.

This must be considered in detail, so far as diet and hygiene are concerned.

D I E T.

As already noted when dealing with the subject of the feeding of infants, the procedure is one that demands the greatest care and supervision, because of their great susceptibility to changes in either the physical or chemical constituents of their food. Furthermore, the problem is of greater importance to the physician, who would successfully treat infantile affections, ^{with} the proper understanding of how to exercise due supervision of the details of infant feeding.

The digestive ferments are less active in infants under two years of age. It is not until the child reaches the age of nine or ten months that ptyalin is secreted in sufficient quantities to act on the starchy foods; and, for this reason, this kind of nourishment should be withheld, or only given in small quantities. Its presence in the infant's stomach only leads to flatulence and dyspepsia, which may retard the peptic digestion, and so pave the way for bacterial invasion of the gastro-intestinal tract.

Owing to the very active metabolic changes occurring in the tissues of the growing infant, its food must consist only of easily digested food constituents. These must be present in the proper proportion, and of sufficient quantity for the needs of the infant, - not only for its present requirements and the carrying on of the functional activities of the body, but also for the supply of new material required in the rapid growth and development of the body. A large quantity of fluids are required to carry off the waste materials of the tissues, and to facilitate the chemical and biological changes associated with cell multiplication. This large quantity of fluid is provided for in the milk, which, on an average, consists of nearly ninety parts of water in every hundred of milk.

Infants, as a rule, should be given their food at a temperature as near the body heat as possible, so that the

digestive action of the stomach may not be retarded through the presence of a large quantity of cold food.

It is as well to avoid weaning infants during the warm months of the summer. When beginning to hand-feed them at this season, the greatest care should be taken to avoid over-feeding or too frequent feeding; for children, like adults, require less food and more fluids in the summer than at other seasons. For this reason, it is wise to give the infant either plain sterilised water that has gone cold, or barley water two or three times a day instead of its usual meals. This, in my opinion, is a better plan than that advocated by some writers, who advise that the milk should be more diluted and given more frequently - a course which necessitates less rest to the digestive organs and more risk of bacterial invasion of the gastric contents.

The amount of proteids, fats, starches, and sugars present in any foods used as substitutes for maternal milk must, as far as possible, be present in the same definite proportions as occurs in the latter food. These proportions must vary with the needs of the infant, and be presented to the latter in as easily digestible a form as possible. If food is not supplied in proper amounts, and also of suitable quality, growth and development of the infant will suffer, in the first instance; whereas, in the adult, it is the work done by the body which is first affected.

There can be no doubt that, until the attainment of the age of eight or nine months, the best food for an infant is its own mother's milk. Woman, like other mammals, should suckle her offspring, for it is the food nature has provided and intended to be used for the sustenance of all mammalia. Consequently, any attempt at its imitation or substitution, however carefully or skillfully performed, is apt to be followed in man or animal by the production of a less robust progeny, as well as a larger number of early deaths.

Take the case of any of the familiar domestic animals, and compare the growth and physical development of those young allowed to suckle their mothers with the ones fed on other articles of food. I have noticed that the death-rate is about five times as great in hand-fed pigs as it is in those allowed to suckle the sow. The same is seen to obtain in the case of foals and lambs; and many of the cases that survive the first few months of artificial feeding afterwards succumb to diseases of the gastro-intestinal tract, especially, and in

larger numbers than those allowed to suckle their mothers.

There are no reliable figures obtainable which show the proportion of mothers in this country who suckle their infants, compared to those who do not. In the city of Derby, according to the Medical Officer of Health, only 63 per cent. of mothers nurse their own infants; and this in a city like Derby, - which is much above the general average as regards the social condition of its inhabitants, - indicates a much less proportion of breast-fed infants in such large centres of industry as Manchester, Liverpool, Glasgow, and other places: the figures must be little short of 50 per cent. Only half the infants born in these places receive maternal feeding alone until they attain the age of eight months. The result of this is seen in the high infantile mortality, from all causes, which characterises the health reports from these cities.

It is an undeniable fact that, at the present day, less mothers are ~~either~~ willing to suckle their offspring. This condition of matters is not limited to any one grade of the population, although the leisured and wealthy class are the principal offenders, - not so much because they are unable, as that they are unwilling to forego their social engagements for the sake of their infants. One can to some extent pardon the poor mother who, compelled by the force of circumstances, seeks to add to the support of her home by going out to work in a factory; but there is no excuse for the well-to-do mothers abandoning the care of their infants to the ~~care of~~ hireling nurses, simply because she may be free to indulge to the full her perverted taste for social amusements and gaieties. It is very difficult to convince these women that they are not only jeopardising the future health and happiness of their offspring, but may also be causing irreparable injury to their own constitution through their selfish conduct, and that the maternal instinct, which should constitute the joy of a mother's existence, is either not called into being, or is only imperfectly experienced.

Amongst the less favourably circumstanced, there appears to be a constant increase in the number of those who are either physically unfit to nurse their infants, or who, by reason of their occupation or employment, cannot give the time necessary to the due performance of the maternal duty; and, in the present struggle for mundane existence, the babe is heavily handicapped.

The present tendency appears to be for young girls of

middle classes to be taught some occupation, which many of them continue to engage in after marriage, to the neglect of their home and family; and, as there is in this country no restriction as to the time that should elapse before the mother is allowed, after giving birth to her infant, to resume her occupation in the shop, office, or factory, one finds that many of these mothers return to their usual occupations within a month from the date of their confinement, trusting their tender infants to the care of unskilled, and often unscrupulous nurses. This class of mothers ought to be encouraged and assisted by the State to devote more of their time to the care of their infants: especially should they be compelled to remain at home, as is done in some countries of Europe, until their infants are six or seven months old; and all mothers should be warned of the risks attending the weaning of infants during the warm weather.

Dr. Howarth has conducted a careful enquiry into the cause of the death-rate of infants from summer diarrhoea. His figures show that infants born during the second quarter of the year contribute the greater number of deaths, and this he ascribes to the custom of mothers weaning their infants when they are only two or three months old. Strange as it may appear, the infants born during the third quarter yield the smallest number of deaths compared with the other seasons - a fact which Dr. Howarth thinks to be due to the mothers either continuing to nurse their infants for the first three months, or perhaps exercising more care in the preparation of the infant's food. Anyhow, as I have shown already, the death-rate of infants from diarrhoea under three months of age is less than at any other age-period under two years. This fact should give us hope that, with the encouragement of maternal nursing and the supply of a pure modified cow's milk to the infants of the urban population of this country, the infantile mortality will be reduced by more than a half of what it is at present.

What sanitation has failed to accomplish, I believe will ultimately be attained by the education of the future mothers of this country in the proper method of nursing, feeding, and rearing their infants. State grants should be made to enable the poorer class of mothers to remain at home and bring up a healthy baby, and for supplying to such infants - who, from physical or other incapacity on the part of the mother, are unable to be reared at the breast - a pure fresh milk,

modified so as to suit the requirements of the infants. Moreover, the milk should be provided at a reasonable price, either by each municipal authority or by private enterprise - subject, of course, to State inspection. On these lines, and on these alone, must we expect to solve the problem of the high infantile mortality of this country; for the solution of this will save, it has been estimated, 500,000 infants' lives every year which are now being simply sacrificed to carelessness, ignorance, and the general decline in maternal care and forethought.

It should be the first duty of the State to see that the girls of today, who may become the custodians of our Empire's greatest asset tomorrow, should be taught how to feed and care for the infants intrusted to their charge as mothers. Classes in infant feeding and domestic hygiene should be attended by every girl before leaving school, and a thoroughly sound and practical course of instruction given. Encouragement for attendance might be given and secured by awarding certificates of merit to those who attained the desired standard of knowledge, without which no girl should be allowed to enter upon the duties of motherhood.

In order to further encourage breast-feeding, and to dispel some of the ignorance with which the hand-feeding of infants is usually undertaken, the Midwives Bill of 1903 might be amended, so that no woman would be allowed to practise her calling for gain until she had passed an examination in the care and management of infants. At present too many of the women attending confinements appear to be quite ignorant of the fundamental and elementary principles of infant feeding and personal hygiene. When one reflects that about two-fifths of the births of this country are attended by women of this class, without the presence of a qualified medical practitioner, one can easily understand the power these women could exercise for good or evil over the community concerned. I know of a small manufacturing town, of 28,000 inhabitants, where 1000 births occurred last year, and of this number only 147 were attended, either alone, or in conjunction with, a registered practitioner from the beginning. This is, however, not an isolated example of the way in which the medical profession are being supplanted by an inferior class of practitioner, - so that the only persons who, by education and training, are qualified to give advice and assistance to the

mother, on the important questions associated with both her own and the infant's health, have their places taken by ignorant and careless women, whose only aim is to pocket their fees with as little trouble as possible.

The remarks of Herbert Spencer are more applicable at the present day, in spite of our boasted educational attainments, than when he said: "Seriously, is it not an astonishing fact, that although on the feeding of offsprings depend their lives or deaths, and their moral welfare or ruin, yet **not** one word of instruction on the feeding of offsprings is ever given to those who by and by will be parents? Is it not monstrous that the fate of a new generation should be left to the chance of unreasoning custom, impulse fancy, - joined with the suggestions of ignorant nurses and the prejudiced counsel of grandmothers?"

ARTIFICIAL FEEDING.

COW'S MILK.

This constitutes the main basis of most of the artificial foods employed as substitutes for breast milk in this country, although sometimes ass's, goat's, and mare's milk, variously modified, may be employed with advantage, - but, to all but the wealthy, the expense attending their use limits their employment.

Cow's milk, as we have already seen, contains a larger proportion of proteids and salts than human milk; and these must be suitably diluted according to the age of the infant, and in other ways variously modified, so that the resulting mixture may, as far as possible, resemble the natural food of the infant. The usual way of accomplishing this purpose is by adding water, which should have its temperature raised to the boiling point and allowed to cool, thereafter adding sufficient fats, in the form of cream and sugar, to bring the constituents up to the proper proportion.

For infants under three months, the amount of proteids in the mixture should not exceed 1.5 per cent., and it is better in most cases - e.g., in delicate infants, or during the summer months - for reasons already given, that the proportion of proteids should not exceed 1 per cent., at least to begin with. This is attained by adding two and a half parts of ^{water} ~~milk~~, previously boiled, to one of milk, to which ^{further} is added a sufficient quantity of cream and sugar of milk

to compensate for the dilution; a little alkaline salt should now be added, in order to neutralise the acidity of the milk, and this is conveniently done by the addition of half to one ounce of ^{lime} water to each feed.

I have found the following plan very convenient and excellent as regards results: It necessitates the use of a relatively small quantity of cow's milk, - a fluid always open to suspicion of bacterial contamination in the summer, - and a larger quantity of water, which can be always sterilised immediately before use. I employ a standardised cream, containing 16 per cent. of pure milk fat, which is put up in sealed bottles of one to two ounce capacity - just sufficient for the wants of an infant during the day and night. The amounts I employ, together with the composition of the resulting mixture compared with that of human milk, will be seen in the following table:

		Composition.	Human Milk
Fresh cow's milk	1 oz.	Proteids 1.1	Human 1.5
Boiled water	8 ozs.	Fats 4.0	4.0
Cream (16 p.c.)	4 1 oz.	Sugar 6.2	7.0
Sugar (Lactose)	3 drs.	Salt 0.2	0.2
Lime or Barley water as desired.		Water 88.5	87.3

It will be seen from the above table that the composition of this mixture is almost identical with that of human milk as therein displayed; furthermore, it is easy to prepare, and its employment has given almost ideal results in the large number of cases in which I have used it.

The above mixture is made up to ten ounces by the addition of a little lime-water; and, where desirable, sodii citras, - two ounces or more, depending on the age of the patient and its powers of digestion, - may be given every two hours during the day, and twice during the night. For example, suppose the mixture is made up at 8 a.m. and the infant fed every two hours, - the mixture will last until 6 p.m., when a fresh supply is prepared to last until the next morning. This entails very little trouble - a factor of the utmost importance amongst a large and growing proportion of mothers and nurses. All that is necessary is to provide an ordinary graduated 10 oz. glass measure, and two ~~narrow~~ glass bottles holding about 10 ozs. each, - one to be kept steeped in boiling water containing a little carbonate of soda, whilst the other is in use. With the glass measure, the necessary amount of milk is

added to the bottle already sterilised, half an ounce of cream is added in the same way, the measure glasses rinsed with some of the previously boiled water, three drachms of sugar of milk added, and the whole made up to $9\frac{7}{10}$ ozs. with boiled water. The mixture is well shaken up, corked with a clean glass stopper, and is now ready for use. It may be heated up to 100°F . by placing it in boiling water; or in the summer it is better to keep it in ice or cold water at a temperature of 50°F .

The feeding bottles should likewise be two in number; and, for the same reason, they should be capable of holding from 4 to 6 ozs., and have an opening at both ends, to facilitate cleansing, as well as a short teat to fit over the neck, the other end being closed with a valvular plug which can be unscrewed. The most scrupulous care should be taken that the feeding bottles, teats, and other utensils used in making up the mixture, are kept perfectly sweet and clean, and also that the residue left after a meal be thrown away, the bottle immediately scalded and placed in cold water.

After the first month the infant may be given 3 ozs. of the mixture ^{every} two hours during the day: this will necessitate the making up of three stock mixtures in the twenty-four hours. At the end of two months the amount of milk in the mixture may be increased to two ounces, and the water diminished to ~~four~~ ^{five} ounces. From the third to the fifth month the infant may receive 4 ozs. of the mixture every three hours between the hours of 8 a.m. and 9 p.m., and once during the night. The cream is to be increased to 6 drachms by the end of the sixth month; from then onwards the amount of milk should be gradually increased and the amount of water decreased, according to the requirements and digestive abilities of the infant, and larger quantities of the mixture given every three or four hours. Plain boiled water, barley water, or thin albumin water may be given between the meals during the summer if the infant requires it: if these instructions be carefully carried out, excellent results will ensue in most cases.

Milk should be obtained from a reliable source, and in a fresh condition. In order to insure uniformity of composition, it is desirable to arrange for the supply of the milk from a good mixed herd - better plan than from a single cow.

Mothers should be discouraged from the common custom of giving their infants part of "anything that is going"; and nothing but the above mixture, or some modification of it,

should be employed during the first eight months of life.

Whilst the above method of artificial feeding is attended with excellent results where the mother or nurse can be depended upon to intelligently carry it out, I am afraid that it will not, at least in the great majority of cases, be attended with the same amount of general success which ensues from the use of a milk prepared on a large scale and distributed in sealed bottles for use. I believe that the solution of the entire problem attending the artificial feeding of infants in this country will ultimately be solved, and with it the present high mortality amongst infants considerably reduced, by the establishment of MILK DEPOTS, either by municipal authorities or philanthropic or private persons. France has already led the way in this matter, with most excellent results; and year by year we are beginning to give more attention to this aspect of the question. Many municipal authorities have already taken the matter up, and the results so far have been most encouraging.

The essential feature of these milk depots consists in the sterilisation of cow's milk, and its modification in various ways so as to resemble as closely as possible the human article. As we have already seen, milk quickly becomes contaminated with various organisms after being drawn from the cow; and, being an excellent culture medium, these rapidly multiply, so that by the time the milk reaches the consumer it may be teeming with organic life. It has been said that London milk contains more micro-organisms per ~~cc~~^{cc} than its sewage! To deliver milk to the consumer in as sterile a condition as it leaves the cow's udder ought to be the aim of all local sanitary authorities. This may in some measure be attained by conducting local milk farms or milk depots; but as the former, owing to adverse criticism from milk vendors and ratepayers, have become unpopular they are now little used in this country. If conducted at all, these farms should be run in conjunction with milk depots, where the milk can be modified according to the requirements of the consumers.

Scrupulous cleanliness should be exercised in all milking operations. The udder and teats should be well washed and dried before milking. The milkers should wear clean overalls; their hands and arms should be well washed in soap and water before commencing; and no one with abrasions or sores on their hands should be allowed to handle the milk.

The health of the staff engaged on the farm must be constantly kept under medical supervision, in order ~~to~~ make sure that no illness occurs amongst themselves or their families which could in any way lead to the contamination of the milk. Both the water-supply used by the cows, and that used in washing the milking utensils, must be beyond suspicion, as well as abundant in quantity; and the greatest care should be exercised in scalding all the vessels used for collecting, storing, transporting, and distributing the milk.

As soon as withdrawn from the cow, the milk should be cooled down to 45° or 50°F., especially in summer, and maintained at this temperature until delivered to the consumers. Milk should never be used for the food of infants after it is twenty-four hours old, and in summer it should be rejected if it is twelve hours or over. In New York, milk purveyors found selling milk with a temperature above 10°C. [50°F.] are liable to have their milk confiscated, in addition to being heavily fined.

Practical experience in this country has taught us the impossibility of attaining such an utopian condition as I have just described, with the result that we have to fall back upon some method which aims at the destruction of micro-organisms in the milk before the latter reaches the stomach of the infant. This is best accomplished by the partial or complete sterilisation of the milk: for practical purposes the former is found to be the most beneficial in results.

Soxhlet was the first to advocate the use of heat for the sterilisation of milk; and since his time a continual controversy has existed, - one school holding that boiling milk alters its nutritive value as a food for infants and predisposes to rickets, scurvy, etc., as well as rendering it less easy of digestion; the other school affirming that if proper care be exercised in procedure none of the conditions aforesaid are likely to arise, and, if they do, the benefits which accrue from sterilisation far outweigh any risk encountered from digestive troubles, or from changes in the blood and tissues. There does seem to be some evidence which shows that rickets and scurvy may attend the prolonged use of sterilised milk; but these conditions can be easily counteracted by the addition of antiscorbutics to the infant's food, or by mixing a little lime-water with the milk. The advocates of ^{un-}boiled milk, however, can offer no advice as to how the acknowledged injurious effects of bacterial activity may be

counteracted.

To completely sterilise milk would necessitate its temperature ^{being raised} to the boiling point for an hour on several successive days. Such treatment would, of course, be attended by alteration in the nutritive value and chemical composition of the milk: in practical dietetics this would be more harmful than beneficial. Instead of this, we content ourselves by raising the temperature of the milk to about 158°F. for about thirty minutes, the procedure being called pasteurisation. At this temperature most micro-organisms found in milk are either killed or rendered harmless, fermentation is checked, and acidity of the liquid prevented; the lactalbumin is not coagulated, and chemically the milk is little altered in composition, - so that if such milk is rapidly cooled in stoppered bottles, it may safely be given to infants.

Whether pasteurisation is to be carried out in the homes of the parents or in central milk depots, must be determined by the social conditions of the people, the demand for such milk, and the price at which it can be procured. The evidence furnished on this subject from France and America shows conclusively that the greater advantages result from the pasteurisation and humanisation of milk at central milk depots, rather than at the homes of the parents, no matter what may be their circumstances.

As conducted in France, these milk depots, or Gouttes de Lait, receive a fresh supply of pure milk twice daily - either from a good dairy farm, or from control farms under the inspection and care of the local sanitary authorities. The milk as soon as it arrives at the depot is at once mixed with the desired amount of water, pasteurised, and put into glass, stoppered bottles, - each bottle containing just sufficient for one meal, and so graduated with regard to quantity and quality as to meet the requirements of all infants at all ages, and under all conditions of health. These bottles are either sent for by the parents or, for a small extra charge, are delivered daily at the infant's home, only sufficient being sent out at a time to serve for twenty-four hours; the empty bottles are collected at the same time and returned to the milk depot, where they are thoroughly cleansed and sterilised before being filled again. In no case should the bottles be opened after they leave the milk depot until required for use, when they are placed in a jug of ^{warm} water, and when the temperature of the milk reaches that of the

water the stopper is removed and the teat slipped over the neck of the bottle. The bottles, when full, should be kept in cold water or iced water in summer. The infants should be fed at regular intervals, and any part of the meal left should be either thrown away or given to grown-up children. The bottle should be immediately washed out and allowed to drain, so that it may be returned to the milk depot dry and free from milk. Two teats should be in use, - one kept soaking in cold water whilst the other is in use, - and the teats should be washed and brushed under the tap, being turned inside out for this purpose. Only sufficient milk to last for a day is given out, Sundays excepted. Mothers are encouraged to attend with their infants, at least once a week, until the child has attained the age of two years, when the infants are weighed, and the increase of weight noted for further comparison, so that any defect in either the weight or the health of the infant is at once detected and an endeavour forthwith made to correct it. Thus we find that these infants receive not only their supply of food from the Gouttes de Lait, but are in addition subjected to a regular systematic medical supervision, which in many large towns in France is supplemented by the visitation of the infants' homes by lady inspectors. The latter are appointed either by the municipal authorities or by philanthropic societies; and ^{part of} ~~their~~ ~~whole~~ duty is to urge upon the mother the importance of suckling her infant; and when this is impossible, from some reason or other, they are required to persuade the mothers to use sterilised milk from one of these depots. They further see that every care is exercised in carrying out the directions supplied to each household using such milk.

Since the introduction of the Gouttes de Lait, ^{by Dr.} ~~the~~ ^{these milk depots} Dufour in 1894, as a separate institution at Fécamp, ~~they~~ have multiplied rapidly throughout France; and similar institutions have been established in some of the larger towns in Spain, Belgium, and our own country.

The first to be founded in England was at St. Helens, in 1899, after a committee of the Town Council had visited Dr. Dufour's establishment at Fécamp. After this followed similar undertakings by the municipal authorities of Liverpool, Bradford, York, Burnley, Finsbury, Battersea, Ashton-under-Lymm, Leith, Dundee, and Glasgow. The results on the whole have been very satisfactory, although not so good as was anticipated, owing to the apathy of the people and the high price charged for the milk in many instances, which placed it beyond the

reach of the poor. It is, however, just the infants of the latter who are most in need of a wholesome and nutritious food supply; and the lack of this is responsible for the largest number of infantile deaths.

Much opposition has also been encountered by the outcry of "municipal trading" endeavouring to kill the industry of private enterprise; this, however, is quite an erroneous view of the matter, as these depots should not be mere milk shops conducted solely for gain, but a means to an end, namely, the suppression of milk adulteration, and the reduction of infantile mortality. Much of the opposition is bound to die out in time, as the people begin to realise that the municipal authorities are only desirous of securing an improvement in the quality of the milk supply; and doubtless we will soon find large dairy farmers supplying sterilised milk on the lines now adopted by certain municipal authorities.

I have had special opportunities of studying the question at St. Helens, the first milk depot to be established in this country. From the following table it will be seen that, while the death-rate amongst infants using depot milk was only half that occurring amongst the infantile population in general, one can only deplore the fact that more advantage was not taken of securing a good sound milk adapted to the requirements of infants up to one year of age.

Years.	No. of Infants fed on Milk	Death-rate per 1000 amongst depot-fed infants.	General Infantile death-rate.
1899	282	103	157
1900	332	102	188
1901	282	106	175
1902	200	82	167

Of the 16 deaths amongst the 200 infants fed on the depot milk during the year 1902, 2 only were from epidemic diarrhoea, equivalent to a death-rate of only 125 per 1000, as compared with a death-rate of 303 per 1000 from the same cause amongst the rest of the infantile population - a reduction of 60 per cent. in the death-rate from epidemic diarrhoea alone.

I believe that better results still would accrue were we to follow the French method, first introduced by Professor Herrgott at Nancy, in 1890, and called by him the Consultation

de Nourisson, the same being found in connection with all the large maternity hospitals in Paris, and dispensaries ~~also~~. Here mothers are encouraged to attend with their babies once a week, and advice is given as to the best methods of feeding and rearing nurslings. Those who are able are induced to suckle their infants, and if the mother's health is unsatisfactory, suitable treatment is instituted. At each visit the infant is weighed, and in some cases presents of clothing, food, or money are made to those whose infants have shown satisfactory progress. At the Clinique Janier, of 527 infants who were under observation 448 were breast-fed; from the moment of birth these infants were constantly under direct medical supervision, and ~~all~~ ^{everything} possible is done to insure successful breast-feeding: where this fails, steps are taken to provide a wholesome sterilised milk, adapted to the infant's age and powers of digestion.

The mortality of infants attending these Consultations des Nourissons, and offshoot the Goutte de Lait, is extremely low when compared with the general infantile death-rate in France. During the five years 1898-1903, the death-rate of infants in Paris was 178 per 1000 births, whereas the infants attending the consultations for nurslings only showed a death-rate of 36 to 45 per 1000 under one year of age. Although many of these infants only attended with their parents for one month, the average duration of attendance ~~being~~ ^{being} under ten months. Of the 712 infants attending Professor Burdin's Consultation at the Clinique Janier during the same five years, not a single death occurred from diarrhœa. It will be seen from the subjoined table that ^{as} number of infants attending these consultations in Paris increases, so does the general infantile mortality decline.

Years.	Death-rate per 1000 under 1 Year.	No. of Infants attending Consultation.
1898	147.8	174
1899	81.0	539
1900	104.0	721
1901	80.0	1438

That this considerable reduction in the infantile mortality is mainly due to the decline in the number of cases of epidemic diarrhœa, is proved by comparing the death-rate from this disease during the two hot summers of 1898 and 1904, in Paris. Although the mean summer temperature of the latter year was higher, and remained elevated for a longer period

than in the summer of 1898, yet the death-rate per week shows a reduction of nearly 50 per cent. During some weeks of 1898, as many as 280 deaths per week occurred from summer diarrhoea, whereas in 1904 it never reached 200 per week, and this in spite of the fact that scarcely more than 4,000 families were either receiving advice from the various Consultations des Nourissons, or feeding their infants on the milk obtained from the Goutte de Lait, during the latter year, as compared with that of 1898 when these institutions were first established.

It is not only in Paris, but all over France - where similar establishments have been founded - that one finds the same reduction in the prevailing death-rate amongst infants. At Saint-Pol-sur-Mer, following the foundation of the Goutte de Lait, the mortality among infants has been reduced from 218 in 1902, to 150 per 1000 births in 1904, and this in spite of the exceptionally hot summer of the latter year. The same thing is seen at Argues, Auscarre, and Varengeville. In the latter town the death-rate, previous to the opening of the Consultation des Nourissons, was 285 per 1000 births; in 1904 it fell to 76.9 - a reduction of nearly 75 per cent. for the whole town; whilst for those attending the Consultation it was practically nil.

Liverpool has four milk depots and forty-four milk distributing shops, where sterilised milk may be obtained, as well as a staff of female inspectors, whose duty it is to visit the homes of those receiving the milk and give instructions as to the method of using it. During the year 1904, the general infantile mortality for the city was 196, and in some places it reached as much as 218 per 1000 births, whilst the death-rate amongst infants attending very promiscuously at the milk depots was only 96 per 1000 births.

It must be remembered that in this country most of the infants attending or receiving depot milk are, to begin with, very much below the average in health, and that many of them are being put on depot milk after all other kinds of food have failed in consequence of their powers of digestion and assimilation being considerably impaired. On the other hand, the deaths among the remainder of the infantile population embrace a large proportion of healthy breast-fed infants, whose chances of surviving the anniversary of their first birth-day is very much greater than in the case of the delicate hand-fed infant; and, if we could exclude from the general death-rate all infants nourished at the breast, we would find

that, instead of the depot-fed infants showing a reduction of 50 per cent., it would be nearer 80 per cent. when compared with other hand-fed infants. Such results as these must convince us of the benefits consequent on the establishment of such institutions as the French Consultations des Nourissons and Goutte de Lait, and the English ^{milk} depots in connection with the out-patient department of all hospitals and dispensaries, or maternity homes, whether supported by public or private contributions, or by a grant from Imperial funds. Here is an opportunity for some philanthropic millionaire to come forward and finance such a scheme, which, if conjoined with teaching of domestic hygiene and the general care and feeding of infants to all girls before leaving school, would, I believe, do more in twenty-five years to better the physical and moral conditions of the people, and reduce our heavy infantile mortality, than all the resources of sanitary science can hope for, or enactments accomplish.

Better results might be attained in this country if we adopted more of the methods of the French Consultations des Nourissons; too frequently our milk depots are run too closely on the lines of commercial milk shops, so as to keep down the municipal expenditure; the infants are never brought to the milk depots; and no medical inspection or supervision over the state of their health is provided for; neither do we, as a rule, provide Lady Inspectors to visit the homes of those receiving the milk and see that it is used properly, - or, if we do provide such inspectors, their numbers are either inadequate, or they possess insufficient training and experience for their duties.

Quite recently the Finsbury Local Sanitary Authority have established a municipal milk depot, managed on exactly the same lines as the Goutte de Lait of France; and Sir John Brunner, following the example of the Mayor of Huddersfield for last year, has promised a donation to each parent or guardian who, at the end of twelve months, has succeeded in rearing a healthy infant, up to the age of one year. Furthermore, he has promised to provide a nurse to visit each mother to assist and instruct her in the care and feeding of her infant. Such beginnings as these are bound to develop; and, if the results obtained in the case of Huddersfield are repeated, I have no doubt similar efforts will be made to extend the system to most of our large centres of industry, where thousands of infants are perishing annually from diarrhoea alone. It is only necessary to arouse the interest of the population

of this country to the frightful waste of infant life which is within our power to prevent, to have the matter taken up in an intelligent manner, and to have this, the darkest blot on our boasted civilisation, for ever removed. Herein lies the true solution of the question: it is not by the discovery of any specific micro-organism of diarrhoea, or yet by the aid of drugs or other agents, that we can hope to reduce the epidemic diarrhoeal death-rate and with it the infantile mortality, - preventive medicine must take precedence of curative, and, so far as diarrhoea is concerned, there appears to be no more promising field in the whole range of medicine than is afforded by this disease.

I have already alluded to the danger which may follow the prolonged use of sterilised milk and briefly indicated how the same may be prevented, but I believe there has been too much made out of this bogey by those who are opposed to the sterilisation of milk in general. The danger I think arises from the promiscuous attempts at home sterilisation, where the milk generally has its temperature raised to 212°F. , whereas depot milk is never raised to above 167°F. , on an average, for twenty minutes, this being sufficient to kill all pathogenic germs in a vegetative state.

I have seen about 150 infants who have been reared on sterilised milk as prepared at St. Helens' milk depot, not one of whom presented any appearance of either rickets or scurvy; nor can it be shown that these disorders are more common in either St. Helens or Liverpool now, than they were eight years ago, prior to the establishment of milk depots.

Sterilised milk has a tendency in some infants to cause constipation, but this can be readily overcome by the addition of a little carbonate of citrate of magnesia to each meal, at the time of removing the stopper of the bottle.

It should be the duty of each municipal authority to see that every inhabitant receives a supply of pure fresh milk. When such a commodity as water can now be supplied in a pure and wholesome condition, surely milk, which is more under our control, can be supplied in a similar state of purity! Whilst the former is indispensable for domestic and public purposes, the latter is becoming more and more necessary as a food for the up-bringing of infants, as well as a food for adults in health and sickness. It has been estimated that the selling value of the milk of the United Kingdom would, at the rate of 4d per quart, amount to over £114,000,000.

CONDENSED MILK.

It cannot be denied that amongst our artisan population the use of condensed milk for infant feeding is increasing. This is doubtless due to convenience in use, ~~that~~ it is cheap and easily procured, and that little preliminary preparation is required to arrange an infant's meal from it - all matters of extreme importance in the family of a working man.

Condensed milk has the following average composition: proteids 11, fats 11, sugars 55 per cent., the remainder being made up with water; and, when diluted to 1 in 16, its composition becomes: proteids and fats .9 each, sugar 4.5 per cent. This, when compared with cow's milk diluted with water to 1 in 2, ^{it} gives a lower percentage of proteids and fats, but a higher quantity of sugar than is found in the diluted cow's milk. It is this difficulty with the excessive quantity of sugar which constitutes the chief objection to the use of ordinary condensed milk, the sugar giving rise to flatulence, fermentation, and acid dyspepsia in the infant's stomach. The low percentage of fats in the food is said to be responsible for rickets; ~~and~~ it has not been shown by chemical evidence that the excess of sugar can altogether replace the fats in the infant's diet. Unless all the elements of the food are present in the proper proportions, evidence of either well-marked developmental defects or nutritive disturbances will arise.

Occasionally condensed milk has been used with success where other foods have been tried and failed. But one should be always careful to see that whole condensed milk is employed and not one of the "starvation brands" now on the market, which, owing to their cheapness, are very extensively used by the poor. It is preferable to employ the unsweetened condensed milk if possible, and to add the desired amount of sugar. Personally, I never abandon the use of cow's milk unless the infant is unable to digest a dilution of 1 to 3, which brings the percentage of proteid matter to about the same as in condensed milk diluted to 1 to 16 of water - the usual degree of dilution employed with condensed milk.

I believe that a good deal of the difficulty one experiences in getting a child to digest cow's milk, who is able to take condensed, depends far less on any ~~special~~ digestibility of the latter than upon the fact that its dilution is out of all proportion to that usually employed with cow's

milk. I have very seldom found an infant who is able to digest a 1 in 16 solution of condensed milk that could not digest cow's milk, if diluted to 1 in 3 and about a grain of sodium citrate added to the ounce. I consider this better than the use of barley or lime-water as it protects against acurvy, keeps the bowels in a state of healthy activity, lessens the size of the curd, and promotes the digestibility of the same: it should always be employed when there is any trouble with the use of cow's milk.

In summer one may sometimes have recourse to the use of condensed milk wherever we suspect the quality of cow's milk supplied, but it should only be employed as a temporary measure to tide over the hot weather, or until a reliable fresh milk can be procured. Personally, I never allow an infant to continue taking condensed milk for more than a month without endeavouring to make it digest cow's milk modified in various ways, and, if one can get the parents to co-operate in this matter, failure is seldom experienced.

Dr. Howarth gives the death-rate for infants fed on condensed milk as 255 per 1000 infants so fed, which is the highest figure recorded for any particular kind of artificial food. He advises that the unsweetened whole condensed milk be used; and, if suitable dilution be employed, he regards it as a very excellent basis upon which to prepare infants' food; but he warns mothers against the use of separated condensed milks which are so extensively advertised, as being devoid of fats; and containing an excess of cane sugar, ^{which} ~~they~~ slowly lead to malnutrition or starvation.

PROPRIETARY FOODS.

These may be divided into two groups: first, those intended to be used as substitutes for cow's milk, and, second, those intended to be used in addition to cow's milk.

In the former group may be classed Allenburys' Nos. 1 and 2, and Horlick's Malted Milk - all of which contain dried milk powder, with the addition of completely converted starch. In Carnick's Soluble Food and Milo Food, the starch is only partly changed into dextrine. In the second group the foods consist mainly of cereals, in which the starch is either partly or completely converted into sugar.

The very extensive employment of these proprietary foods must be strongly deprecated; the laity are too apt to

attribute undue weight to the alluring advertisements extensively circulated regarding the usefulness of this class of diet. One can understand the young and inexperienced mother, in her anxiety to see her infant thriving, trying in turn every class of food recommended by her ignorant but well-meaning friends or neighbours. It should everywhere be made known that, as a rule, these so-called infant foods can never replace fresh cow's milk in the infant's dietary, and that if these foods are used for any length of time to the exclusion of fresh milk, rickets or scurvy will invariably follow, unless antiscorbutics are mixed with them or fresh beef-juice given in addition to the patent foods.

These foods vary widely in the relative proportions of fats and carbohydrates which they contain; that of the latter ranges from 55 to 75, and the former from 2.5 to 16 per cent. It is the deficiency of fats and excess of carbohydrates which renders the prolonged use of these foods, like that of condensed milk, unsuitable for infant feeding; for, no matter how we try, no dilution of these foods can adjust these proportions of fats and starches so as to make them correspond with the percentage composition of human milk.

There is another point which is frequently overlooked when comparing the relative composition of various food stuffs, and that is the physical state in which the various components exist. Thus, two foods may be exactly alike in the proportion of fats which they contain, and yet differ widely in their fat values, - for example, in the various forms of dried milk, the emulsion of fats, when the necessary dilution with water is effected, is never so perfect as in the case of fresh cow's milk. For, when such a mixture is allowed to stand a few minutes, yellow droplets of fat are seen to rise to the surface; so that, after the infant has taken its meal, a considerable amount of fat is found adhering to the sides of the bottle. And, even should ~~all~~ the fats contained in the food find their way to the infant's stomach, their assimilation may be both imperfect and delayed, and this will in time bring about digestive troubles or predispose to profound changes in nutrition resulting in disease. This is especially so when the food is one containing a large proportion of unchanged starch, which acts as an intestinal irritant, and is, moreover, of no nutritive value to the infant. If it is necessary, therefore, to employ any of these proprietary foods, one should be selected which contains no unaltered starch,

for there are few infants under 9 months of age who can digest starchy foods.

Of those foods which are intended to be mixed with cow's milk, Mellin's Food I have found productive of the best results, for the reason that all the starch is here converted into sugar, and infants appear to be able to digest it. In my own cases it has given more uniform results than any of the other foods of this class, although Allenburys' No. 1 is frequently satisfactory. These foods require no admixture with cow's milk, and are very convenient to prepare. They may, moreover, be used during the warm weather in cases of delicate infants who are unable to digest a 1 to 3 dilution of cow's milk, or where one is suspicious of the milk used; but they should not be continued for more than a month at a time. If, under any circumstances, it is necessary to use them for more than this period, a little fresh beef-juice should be given once a day; and, at the earliest opportunity, a return to cow's milk should be insisted upon.

Dr. Howarth, whom I have already quoted, gives the rate of mortality amongst infants fed on proprietary foods as 202 per 1000; whereas, in the case of infants fed on cow's milk, it was only 177.

II. H Y G I E N E.

General Hygiene.

The general hygienic treatment resolves itself into providing good, airy, clean, and well lighted homes. The streets should have an impervious and level surface, kept well watered in summer. All horse manure, and other filth, should be quickly removed, and not simply brushed into heaps near the pavement to become dry and blown about by the wind. Courts, back-passages, and yards should all be made with concrete and cement, or some impervious smooth material, and have a fall of surface towards a trapped drain inlet which can be brushed or washed down. Each inhabited house should have a plentiful supply of pure water. Drains and sewers should be constructed of impervious material, well jointed, and laid with a good fall, provision being made for their frequent flushing during dry weather. All sewers and house drains should be properly and adequately ventilated;

and the outlet of no ventilating shaft should be near a window, but be carried well up above the eaves of the house.

The traps of all drains, water closets, and slop closets should be properly constructed, and periodically ~~constructed~~, and periodically examined, to see that they are acting efficiently; no garbage or house refuse should be allowed to accumulate in or around dwellings; and ^{an} efficient system of scavenging should be instituted in all towns; and more frequent removal of decomposing animal and vegetable matter should be insisted upon, especially among the poor in overcrowded quarters; during summer; ~~and~~ the water carriage system of sewage removal should be adopted in all towns of over 10,000 inhabitants.

Printed instructions should be issued to all parents and guardians having the care of infants as to how they should be fed, the advantages of breast-feeding being pointed out and encouraged. Lady Sanitary Inspectors should be appointed to visit and instruct poor mothers as to the proper feeding and rearing of infants; and to this end also earlier registration of births should be insisted upon. The Infant Life Protection Act of 1897 should be amended; and the State should exercise closer supervision over the insurance of infant life, especially amongst the poorer classes.

P e r s o n a l H y g i e n e .

This consists of, wherever possible, in removing the infant to the country during the summer months, - from, say, June to September. Such a plan has given excellent results in many of the American cities; but, unfortunately, the great majority of the infants ^{who} die from summer diarrhoea are the children of the poor who are unable to carry out such a proposal. Until the State realises its duty towards the protection of these unfortunate infants, we must content ourselves by encouraging parents to take their infants out every morning and afternoon when the weather permits; and these people should be taught the great importance of fresh air and sunlight to ~~the~~ rapidly growing infant.

The proper clothing of infants constitutes a very important part of their general well-being, and should receive the utmost care. Warm loose clothing should be employed. The trunk should not be unduly clad, and the limbs must ^{not} be left bare, especially during cold weather, ~~and~~ the clothes should be frequently changed. Napkins, especially in summer, should

be removed as soon as they become soiled; they should be placed at once in boiling water or, ^acheap disinfectant, in which they are allowed to soak before washing. The child should have a daily bath each morning.

Everything possible should be done to discourage the reprehensible practice of giving the child a "comforter" or "dummy"; for, in my experience, these are a constant accompaniment of a great many of the gastro-intestinal troubles which beset infants; and, in the light of further investigations, may be found to be one of the direct means by which pathogenic and putrefactive micro-organisms reach the stomach of the infant. From several of these "dummies" which I have examined, bacteria and cocci were isolated on gelatine plates. Some of the bacteria resembled the bacillus coli of Escherich. The cocci were chiefly of the staphylococcus or streptococcus variety.

Delicate and rickety infants should not be taken out after dark. The sleeping apartment of the infant should be an airy, well ventilated room with large windows, which may be kept open during the day and night in summer: it should not be on the ground floor. Infants should not sleep with their parents or nurses, but in a cot beside the bed. Provision should be made for heating up their night meals. The bedclothes should be clean, fresh, and not too weighty, and it is better to have several light layers of these than only one or two heavy ones. The nursery should be large, clean, and airy, with a southern aspect, and be well ventilated before the child enters it in the morning. Heavy articles of furniture should be avoided; and thick carpets, rugs, and curtains should find no place in a well appointed nursery. Amongst the poor, the best room in the house should be set apart for the use of the infant, instead of the custom of keeping these delicate nurslings penned up in the hot and vitiated atmosphere of the kitchen or living room. It is just in proportion to the extent to which these dietetic and hygienic rules are followed that epidemic diarrhoea prevails amongst infants.

I am constrained to write at the present length on this aspect of the subject because of a strong conviction, - based on five years of close observation of this malady amongst infants; - that the prevention of this disease consists in placing the infants of this country under the best possible surroundings, such as exist in ^{rural parts of the} ~~this~~ country, and in seeing that their diet is in every respect suited to their needs and

indications. The education of the future mothers of our race, and additional legislative enactments are important desiderata. No field in prophylactic medicine offers such encouraging results as the prevention of epidemic diarrhœa. It is no exaggeration to state that two-fifths of the present high death-rate amongst infants could be prevented by us; and, in the memorable words of King Edward VII, "if preventable, why not prevented?" The solution of the so-called problem of physical degeneracy of our race, if it is to receive proper attention, must be approached by way of the infantile population of this country, - the more so, indeed, if we accept Dr. Broadbent's dictum that for every infant life lost under one year of age, the constitution of five or six are either weakened or irreparably injured by the same agencies which accounted for the death of the one.

(B) TREATMENT DURING THE ATTACK.

This is best considered under the headings of dietetic and therapeutic.

DIETETIC TREATMENT.

Careful attention to the infant's diet is of the utmost importance in the management of all diseases. This is especially true in the case of such a disorder as epidemic diarrhœa, where the digestive functions are primarily involved and incapable of performing their work, so that the entire system suffers in consequence. A proper understanding of the physiology and pathology of the gastro-intestinal tract is of the utmost importance to all who would successfully attempt to treat disorders of the alimentary tract in infants. No less important also is the question of the composition of the various natural and artificial foods employed in the feeding of infants either in health or disease; both these subjects have already been dealt with by me above, and with sufficient emphasis, too, as to make recapitulation unnecessary.

It may be laid down as a general rule in the treatment of summer diarrhœa that all milk should be stopped at once, unless, of course, the infant is entirely fed on the breast.

C. G. Kerby gives the results of his treatment of 555 cases of summer diarrhœa, and points out the advantage of at once stopping all milk, whether the infant is breast-fed or

hand-fed. "In our management of summer diarrhoea", he says, "we have one invariable rule of treatment regardless of the severity or duration of the illness, regardless of the diet whether breast-fed or hand-fed, whether the stools are frequent or watery or infrequent and foul. *We stop the milk at once.* This is based upon the belief that in every case of summer diarrhoea we have an infected gut, or soon will have, and we wish to make the intestinal contents as ~~poor~~ a culture medium as possible". He allows no milk until the stools return again to the normal, no matter how long that may be.

Whilst I agree with much that Dr. Kerby has said, and with his reasons for withdrawing milk during the illness, I am not prepared to go as far as this authority with regard to discontinuing the breast milk entirely, unless the mother's milk is in some way at fault, and then only to discontinue it temporarily. The healthy breast milk is a sterile secretion, which, in its physical and chemical composition, contributes the most suitable nourishment for the varying needs of the infant; so that, to at once cut off this supply of food and substitute some other article of diet, would not under all circumstances prove beneficial either to the mother or infant. In some cases the temporary substitution of a little albumin water or barley water will lead to an improvement in the symptoms; but the vast majority of breast-fed infants require nothing more than a little regulation in the number of nursings, and due attention to the mother's health, to bring about the desired improvement, - with, possibly, the administration of a small dose of castor oil or calomel, to clear away the fermenting food from the stomach and intestines, followed by a bismuth and chalk mixture.

It is the hand-fed infants, however, who require the greatest care and supervision during the course of this disease: these infants, unfortunately, represent more than 90 per cent. of the total number of the deaths from epidemic diarrhoea. The fact has already been emphasised that most of these attacks are brought about by overfeeding, or by irregularities in the method of feeding, as well as the exhibition of inappropriate materials. It is never wise to ask if the child is breast-fed, for many mothers will give an affirmative reply to this question, when, as a rule, the infant is only partially fed on the breast. When such a method of feeding is employed (as will be found in a large number of these so-called breast-fed cases), all food other than the breast milk should be withheld, and the mother instructed how often, and how long,

to nurse her infant - provided, of course, the infant is strong enough. Careful attention should also be given to the breasts and nipples, both before and after nursing: when, however, the infant is unable to suckle the breasts, the milk must be carefully pumped out, and the infant given an ounce to an ounce and a half every two hours.

In the case of an infant entirely fed artificially, a wet nurse might advantageously be procured when the parents' social circumstances will allow of this. But the dangers and drawbacks contingent to this method of feeding limit its application, especially as it is just those people who are too poor to afford the services of a wet nurse whose infants suffer most from diarrhœa. As a rule wet nurses are more useful as a prophylactic than as a curative measure for this condition. Sometimes, however, they may be employed with advantage when the infant is convalescing from this disease, especially if it is found that their milk agrees with the infant and that artificial foods cause relapses. In my experience it is no good attempting to reduce the quantity of artificial food. All milk and other artificial foods should be stopped from 12 to 24 hours or longer, and only plain boiled water, which has gone cold, barley water, egg water, or milk whey given in small sips frequently, after a dose of castor oil has been exhibited. This has been called the "starvation and eliminative treatment"; and it may be continued for two or three days, or until such time as the stomach and intestines have cleared themselves of undigested and fermenting food residue.

All directions as to feeding should be given in writing, and with the same exactitude as in the case of drugs. We should avoid the too frequent change of foods or drugs until satisfied that what is being given is unsuitable.

Sometimes, owing to the persistency of the vomiting, nothing may be retained in the stomach for many hours, or even days, at a time; during which period the thirst is often intense. A liberal supply of bland fluid should be given, in small quantities at frequent intervals; and, even if rejected immediately, some will remain behind; even the return of fluids is beneficial during the first few hours of the attack, as it helps to wash out the stomach. In my experience, the best fluid to give during this period is egg water. This is prepared by whipping up the white of one fresh egg in half a pint of sterilised water, to which may be added a few

drops of brandy, if there be evidence of collapse; or, if the vomiting is severe, with the addition of a few grains of salt: such a fluid may be given ad libitum for several days at a time. In less severe cases barley water, plain boiled water, - to which a little lime-water is added or, if necessary, a little ^{white} wine or milk whey, - may be employed.

After the first storm of vomiting has subsided, and the stools are reduced in number and normal in character, a little weak veal broth, chicken broth, or milk whey and white wine, may be given in half ounces every half hour. In the course of a day or two, - depending upon the nature of the stools, - the egg water or barley water may be diminished gradually, or discontinued if there is no thirst, and either a little peptonised milk or beef-juce substituted. The milk at first should be peptonised for two hours, by which time all ~~its~~ proteid will have been converted into albumin and peptone; a little lemon-juice is added to sweeten, and the whole diluted with one-third its bulk of lime-water.

At this stage many infants will do well on Nestlé's Condensed Milk, given in the strength of a drachm to the ounce of boiled water. It possesses the advantage of being ~~sterile~~, uniform in composition, and handy for use; and, if proper care be exercised in preparing it and attending to the general hygiene of the infant's feeding utensils, it gives very good results, - especially in the case of poor infants, where expensive foods and elaborate dietetic details are out of the question.

It is advisable to keep the infant under observation for some weeks after convalescence has begun, and to return to ordinary cow's milk gradually and, at first, tentatively, especially in the case of young delicate infants residing in crowded and unhealthy localities during the hot weather. The same care and precaution should now be taken to guard against relapses, the details of which have already been given in the section devoted to prophylaxis. On the slightest indication of any gastro-intestinal disturbance, all milk should be stopped and the return to egg albumin water, white wine, whey, etc., be immediate.

If during the course of the illness recourse be had to the use of peptonised milk, care should be taken not to continue its exhibition too long. The difficulty in exercising control over this article of diet, especially amongst the poor or in dispensary practice, makes me very reluctant to

prescribe it, unless I am satisfied its use will be protected from abuse; for, if too long continued, it will certainly give rise to symptoms of scurvy, or other nutritive disorders. I recently came across a case where the mother was continuing its use for her child, during a period of upwards of two years. She had been so impressed with the beneficial effects of the milk that she was actually feeding another infant, aged three months, on it also, although this infant had apparently never had any gastro-intestinal affection; it was with extreme difficulty that I succeeded in inducing the mother to discontinue the peptonised milk, especially as at first great difficulty was experienced in getting in getting the elder of her two children to digest any kind of food except this. In this case, fortunately, the medical man who induced her to peptonise the milk gave instructions that it was only to be peptonised for half an hour, so that the casein was only partly peptonised, and the glandular functions of the stomach were not completely in abeyance during digestion.

It is my custom to allow all cases of summer diarrhoea to drink freely of plain boiled water during the first two or three days of the illness. As already stated, this allays thirst, aids metabolism, dilutes the inspissated condition of the blood, flushes from the system the products of bacterial activity, and supplies to the depleted tissues the fluids which are constantly being carried off by the intestinal flux. Half to one ounce may be given every ten to fifteen minutes if the infant will consent; but care must be taken not to continue its use too long, or it will cause the stools to remain fluid after the disease is recovered from. When the thirst begins to abate, vomiting ceases, the temperature drops to normal, the pulse becomes slower, fuller, and more regular; the tongue and mouth moisten, the shrivelling up of the tissues stops, and the infant ceases to lose weight. We should now discontinue the free use of water and give something more substantial, such as veal or chicken broth. It is best to give all fluids cold, except in cases of threatening collapse, or where we are dealing with a case of true cholera infantum, when a little tepid water and a few drops of brandy may be employed. It is always advisable to give fluids, or other food, immediately after an attack if vomiting ^{subsides} exists, as they are more likely to remain in the stomach sufficiently long for some of them to be absorbed. When the exhibition of fluids by the mouth invariably incites vomiting, recourse may be had

to the use of enemata, or to the hypodermic injection of fluids.

LOCAL TREATMENT.

BATHING.

This is of considerable benefit in the treatment of diarrhœa in infants; it allays restlessness, reduces the temperature, and encourages the action of the skin and kidneys in getting rid of the toxins produced in, and absorbed from, the alimentary tract. In all cases where the temperature exceeds 102°F. , I advise that systematic bathing should be had recourse to two or three times in the twenty-four hours; and, if the infant is suffering from hyperpyrexia, the bathing may be employed every two or three hours until the temperature is considerably reduced. It is often very difficult to get the bathing performed in a satisfactory manner at first; and the physician in this, as in all other treatment directed towards the cure of diseases in general in infants, should either give implicit instructions in writing to the nurse or mother, or superintend the carrying out of his advice to commence with; when often the beneficial effects, in the way of peaceful slumber, will be proof positive to those in charge of the nursing arrangements, of the desirability of carefully attending to all advice proffered. It is my usual custom to direct the bath to be given at a temperature of 96° to 100°F. , and to be gradually reduced to 85° or 80°F. , by the addition of ice. The infant remains in this from ten to fifteen minutes, - depending on the height of the temperature, the presence or absence of collapse, and the age and strength of the patient. Sometimes a little brandy may with advantage be prescribed with the bath, if the infant is very exhausted. The infant when removed may be rolled in a warm blanket, and then covered with a sheet; in less than half an hour it may go to sleep, to waken up afterwards with the temperature much reduced - sometimes as much as two or three degrees in an hour.

W a r m b a t h i n g may be employed in cases where there is not much elevation of temperature. It is of most benefit in such cases where there is much prostration, nervous apathy, and the other phenomena of the encephaloid variety of the disease, or, again, in those accompanied by convulsions. The temperature of the bath may be from 106° to 110°F. , and the infant allowed to remain in it from three to five minutes, and on removal rolled in a soft blanket, after being well

dried. This form of bath has been found very useful in those cases ^{accompanied by} ~~of~~ diminution or suppression of urine; it causes diaphoresis and diuresis, and brings about, by stimulating the nerve centres in the brain and medulla, a general improvement in the symptoms. Sometimes the addition of a little mustard to the bath will prove useful in stimulating the nerves of the skin, and in increasing peripheral circulation. Hot blankets, or hot water bottles, may be placed around the infant after removing it from the bath. This is especially useful in cases with suppression of urine, as it stimulates the skin to a marked degree.

The wet pack and cold sponging are useful in the same class of cases as are benefited by the cold bath. It is often advisable to administer a little brandy, or other stimulant, before putting an infant in a wet pack. Careful watch should be kept over the infant during the time it is in the cold bath or wet pack, and it should be at once removed therefrom should signs of threatening collapse make their appearance. Should the temperature, instead of falling, continue to rise, either during the time the infant is in the bath or after it is taken out, we must discontinue the cold bath or wet pack, and resort to sponging or tepid bathing instead.

GASTRIC LAVAGE.

The washing ~~out~~ of the stomach is a very useful procedure when we see the case sufficiently early, especially where the vomiting is either absent or very incessant, and also when collapse is rapidly supervening, as is seen in many of the cases of cholera infantum. Its object, in the first class of cases, is to quickly clear the stomach of fermenting food, and, in the second class, to relieve the irritability of that organ.

For the purpose of this operation, a No. 7 or 8 gum elastic catheter is passed into the stomach, either through the infant's nostril or mouth, and three or four ounces of warm water, at 95°F., are allowed to flow by gravity, from a height of two or three feet, into the stomach. The funnel of the tube is lowered and syphonage established, whereby the fluid is returned, bringing away some of the contents of the stomach. The operation may be repeated several times, - although this is seldom necessary, - until the fluid returned is quite clear and free from any heavy sour odour.

This operation is very much used in Germany, where Siebert advises the addition of benzoate of soda [3 per cent.] and resorcine [gr. $\frac{1}{2}$] to the fluid employed, a little of which should be allowed to remain in the stomach after each washing. I have found that a few grains of borax answers the purpose equally well, except in very bad cases, or where there is much vomiting or irritability of the stomach. A little egg albumin, whey, or chicken broth may be introduced into the stomach in the same way, after the organ has been washed out; and very often we may thus succeed in getting the infant to retain food when all ordinary methods have been tried and failed. Furthermore, it is a procedure which I can from an extensive personal experience, highly recommend in all cases where the taking of food in the ordinary fashion incites the act of vomiting. A good intelligent nurse is necessary, and the parents should be requested to retire whilst the proceedings are being carried out. There is practically no danger of passing the catheter into the larynx; and, owing to the shape and position of the infant's stomach, the fluid is quickly returned in depressing the glass funnel attached to the catheter.

IRRIGATION OF THE LARGE INTESTINE.

This operation consists in washing out the lower bowel as far up as the ileo-caecal valve. It is a most useful adjunct to the washing out of the stomach. Like the latter, it should be performed at once in acute cases; but it is also very useful in dysenteric diarrhoea or mucous colitis, which sometimes follow on an attack of epidemic diarrhoea. In the first class of cases, its action is to remove decomposing food and bacteria, and, in the second, to enable the inflamed mucous membrane to become soothed and to heal.

The buttocks should be raised, and a large-sized rubber catheter passed gently up the colon to, if possible, beyond the sigmoid flexure. The amount of fluid introduced will depend upon the age of the patient, and the height to which we desire the fluid to reach: as a rule, we may use from twelve to twenty ounces for infants under one year of age. The fluid should be given a fall of two to three feet, which will usually insure its reaching high enough to clear out most of the large intestine. Warm water should be used in all cases, to which one may add a little borax, boracic acid, or other mild antiseptic; and, in bad cases, it is usually necess-

ary to repeat the operation two or three times before the escaping fluid is clear.

Sometimes one may wish to diminish the peristaltic activity of the bowel, stimulate the system, or soothe the mucous membrane, which is done by the further addition of various special agents to the fluid used for irrigating the bowel. For these purposes astringents, opium, brandy, and starch may be employed. Again, in the case of hyperpyrexia, the use of cold water enemata, after the preliminary irrigation, is one of the most rapid methods of reducing the temperature - provided, of course, the infant is strong enough to withstand the shock. Personally, it is a method I never employ in very young infants or weakly children, believing that the graduated cold bath or cold pack to be superior and more convenient of use.

One may occasionally have to employ nutrient enemata in some cases of persistent vomiting accompanied by collapse; such treatment, however, should always be preceded by a large irrigation of warm water, in order to remove the debris and soothe the intestinal mucous membrane. The employment of a warm normal saline enema may be necessary in some cases of severe collapse, so as to make up for the loss of fluids by the bowel. This saline enema is best given in two portions of ten to twelve ounces each; the second portion to be given immediately after the return of the first; and, if necessary, the operation may be repeated once or twice daily.

HYPODERMOCLYSIS.

This operation is indicated in some cases of great collapse, with a rapid small pulse and shrunken tissues; and also where the disease is progressing rapidly with severe diarrhoea, vomiting, and sudden loss of weight. A normal sterile solution of chloride of sodium is employed. In order to avoid the shock resulting from puncture of the skin, a very fine needle must always be used. The injection is made into the cellular tissue of the groin or axilla; and about four or five ounces of the solution is injected slowly; and, if there be no improvement, it may be repeated every six or eight hours.

Thus form of medication gives very good results in some almost hopeless cases, especially when combined with small doses of strychnine; but, unfortunately, it is not easy in all cases in the homes of the poor to carry out these mechanical means of treating this disease. I have employed hypodermocl-

ysis in eight dispensary cases, - three of which were true examples of cholera infantum, - and in all the results were very satisfactory, especially when aided, ~~when specially indicated~~, by hypodermic injections of strychnine (gr. 1/200) every two or three hours.

Cases for hypodermoclysis should be selected with care, and the parents warned that this is a last resort, or else we may incur discredit by performing what ~~the parents~~ ^{they} are apt to consider a serious, and, to their minds, a needless operation.

THERAPEUTIC TREATMENT.

Drugs are the least useful of all the means at our disposal for the treatment of this disease, and the number of remedies which have been at one time or another employed in the treatment of this condition, only serve to emphasise the fact that there is no one drug, with which we are acquainted, that can be regarded as a specific in the summer diarrhœa of infants. In the therapeutic treatment of children, it may be laid down as an axiom that drugs should never be administered without a clear and specific purpose in view; this is particularly true in the case of infants suffering from diarrhœa, where, unless the pathological condition is kept in mind, the unwarrantable and careless exhibition of drugs may do more harm than good.

The successful treatment of this disease resolves, ^{itself} into clearing away the irritant material from the stomach and intestines, and in subsequently endeavouring to counteract the ill effects of the products of bacterial activity upon the nervous system and heart. The first purpose may be effected by the use of castor oil, rhubarb, or mercury.

CASTOR OIL.

This agent is indicated for those cases seen during the first twenty-four hours of the onset, or where there is much irritation of the stomach, and also where we suspect the presence of irritating particles of undigested food in any part of the alimentary canal. For infants under one year it is given in doses of thirty to sixty minims, combined with a little glycerine and peppermint water to flavour it. Such a mixture will efficiently sweep out the whole intestinal tract, and without giving rise to any irritation or griping. The after-effects of the oil is constipation, which, together with its sedative action on the mucous

membrane,- renders this eliminative treatment with castor oil a most certain and beneficial one. Some think, however, that better results follow the repeated exhibition of small doses, say, ten to fifteen minims every four hours. Whilst I do not deny that this method of treatment gives fair results in cases which have lasted three or four days, and where the symptoms of the acute attack are passing off,- I have, as a rule, obtained the best results by the employment of the oil in large single doses repeated, if necessary in from six to ten hours. As the element of time ^{is} of considerable importance in acute cases, it is evident that a dose of oil, sufficient to clear out the contents of the ^{bowels} in a few hours at most, must be preferred to the delay consequent on bringing about purgation by several small doses repeated every three or four hours; for, during this delay, intestinal decomposition is going on rapidly, and the resulting toxins are being absorbed and conveyed to the nervous system.

RHUBARB.

Rhubarb is another useful drug in the eliminative treatment of this disorder, and it may be given in conjunction with castor oil, thus:

R.

Ol. ricini m. xx.
Tinct rhei,
Glycerini aa. m. x.
Aq. menth. pip. ad 3i.

In stead of this, however, we may use the following mixture, especially if the stools are green and there is much vomiting:

R.

Pulv. rhei gr. iiii.
Sod. bicarb. gr. v.
Pulv. tragacanth. gr. i.
Aq. menth. pip. ad 3i.

The well-known astringent action of the rheotannic acid of the rhubarb is very beneficial in diminishing the amount of intestinal secretion. These prescriptions are intended for infants under one year of age, and may, when necessary, be repeated every few hours until the desired result is obtained.

Hutchinson strongly recommends the use of the compound rhubarb powder [Gregory's powder], in doses of 5 to 20 grains; but, as it is apt to give rise to griping pains, I prefer to use the castor oil alone, or combined with rhubarb, as in the above mixture. I do not advise the use of powders in the case of infants under a year old, as they are difficult to administer, and the results are not so certain.

MERCURY.

This is believed to be one of the best of the therapeutic agents that we possess for the treatment of the disease, but it must be employed with care. It may be used when the case first comes under observation, or after the above-recommended emptying of the stomach and intestines is ~~accomplished~~ ^{accomplished}. Since we have begun to realise that most of the symptoms associated with this disease are dependent upon bacterial activity in ^{the} alimentary tract, efforts have been directed towards the discovery of some agent which would arrest these bacterial changes in the bowels; for, however drastic our attempts may be to clear out the intestinal contents, we cannot hope to free it entirely of the bacteria which adhere to the mucous membrane. To destroy these, or at least inhibit their growth, mercury, amongst a host of other drugs, has been employed; but, as the chief habitat of putrefactive micro-organisms is the large intestine, it is very doubtful if any antiseptic given by the mouth ever reaches this part of the bowel in sufficient concentration to influence the bacterial growth. Nearly all gastro-intestinal antiseptics have, for this reason, proved failures; and, from what has been said regarding the bacterial flora, it is not at all remarkable to find that such is the case.

Mercury may be employed in the form of calomel, the perchloride, blue pill, or grey powder. Calomel may be given in 1/4 to 1/6 grain doses every hour, until a grain has been administered. When combined with the subnitrate of bismuth, it possesses marvellous effects in checking fermentation and allaying vomiting during the early stages of the disease, especially in cases where there is not much collapse. Personally, I prefer this combination to that of any other form of mercury, although grey powder with a little aromatic chalk may sometimes prove more successful, especially if the case is one of the milder forms of the disease frequently seen about the beginning of the summer.

Dr. Eustace Smith speaks highly of the combination of

calomel with Dover's powder, given in doses of a quarter of a grain each; but, unless there is much tenesmus and the bowels are already well cleared, the employment of opium is hardly indicated at this stage. Although it is very questionable if opium, in the form of Dover's powder, is to any extent absorbed by the intestines, the ipecacuanha undoubtedly has a beneficial effect on the mucous membrane. Furthermore, unless the case is one of simple dyspepsia, it is never wise to arrest the diarrhœa by the use of opium, and much harm may result if the nervous symptoms predominate.

OPIUM.

This is a very useful drug in the treatment of this disease, that is, when it is carefully used. In spite of much that has been written to the contrary, infants tolerate opium very well; but it must be given with a clear and definite purpose, and not administered in a haphazard way, simply because the infant is suffering from diarrhœa. As already stated, it should never be employed in any form where there is much drowsiness, apathy, stupor, high temperature, contracted pupils, diminution in the amount of urine, or where the discharge from the bowels is very small. Should any of these symptoms appear during its administration, the opium should either be very much diminished in amount or stopped entirely, for a ~~while~~^{time} at least. It is best given during the excitable stage of the disease, - when insomnia, restlessness, and pain are present, - or where the stools are very frequent, watery, or serous in character, or in those cases when the bowels are moved soon after taking food. Opium quietens the nerve centres, diminishes reflex irritability, relieves pain, stimulates the inhibitory fibres of the sympathetic in the stomach and intestines, thereby retarding peristaltic activity and lessening intestinal secretion. It likewise exercises a stimulating action on the heart, which is sometimes very beneficial in the restlessness accompanying the early stages of this disease. For this reason, many of the American physicians give one or two minims of the deodorised tincture with the castor oil; but here it must be remembered that a larger dose of the oil is necessary, - for should the latter fail to cause a thorough clearing out of the bowels, the opium may paralyse peristalsis and aid putrefactive changes. I am in favour of giving the oil alone, and only employ opium when I am satisfied that, from the number and nature of the stools, the irritating contents of the bowels have been got rid of. I agree,

moreover, with Holt that we should never include opium in a mixture, but give it by itself, - either in the form of paregoric or, what I consider better, the deodorised tincture, made up with a little simple syrup and flavoured with some cinnamon water. About 8 - 12 minims of the paregoric, or $\frac{1}{2}$ - 1 minim of the tincture, may be ordered every 1 - 2 hours, - according to the symptoms, age of the patient, and the effects of the drug, - stopping it, of course, when any of the contra-indications aforesaid make their appearance. I regard the use of small and frequently repeated doses of much more service, and certainly safer, than the exhibition of a large initial dose. For no two infants react alike to opium; and, if it is not most carefully watched, it is more likely to do harm than good. Indeed, many of the accidents resulting from its indiscriminate use are probably due to the manner in which it has been employed; for, of all the drugs at our disposal in the treatment of this disease, none require more careful handling than opium, and it should therefore be discontinued once the indications for its employment have ceased to exist.

Dr. F. M. Cradall, discussing the value of opium and the indications for its employment in summer diarrhoea, gives the following rules for its use: "(a) Very frequent motions accompanied by pain. (b) Extremely frequent, large, and watery movements of the bowels. (c) Dysenteric diarrhoea (after the administration of a saline or castor oil). (d) In the later stages of diarrhoea with small frequent nagging passages. (e) When the passages consist largely of undigested food and ^{leave} the bowels, ^{immediately after food is} ~~are~~ taken into the stomach." He considers opium, or any of its preparations, contra-indicated: (a) During the early stages of acute diarrhoea. (b) When the motions are infrequent and of bad odour. (c) In the presence of high fever or cerebral symptoms. (d) When the use of the drug is followed by elevation of temperature, or increasing of the stools.

The excessive thirst, experienced at this stage of the disease, may be overcome by giving sips of iced water, especially if there is much vomiting, boiled water, rice water, or barley water, every ten minutes, as already explained.

ACETOZONE.

During the last two summers, I have been using a cold aqueous solution of acetozone - a speciality manufactured by Parke, Davis & Co. I have been led to employ it in this disease from the good results obtained from its exhibit-

ion in typhoid fever. Chemically, this substance is a white crystalline powder, soluble in water. It is described as benzoyle-acetyl-peroxide. Benzoic acid is liberated when it is dissolved in water, and some of the water undergoes hydrolysis. I use it in the strength of 5-10 grs., dissolved in a pint of warm water, and ~~also~~ allow infants to drink as much of it as they will; it may, moreover, be added to their milk or other foods. For typhoid fever in adults I use 20-30 grs. of acetozone, dissolved in a pint of water; the contents of the pint bottle are well shaken, every five minutes, to insure complete solution; it is then allowed to stand until the fluid is cold; when the clear solution is decanted off and given, ad libitum, to the patients, flavoured, if need be, with a little lemon water. For epidemic diarrhoea, the weaker solution is prepared in the same way; and I always begin using it freely after the bowels have been well cleared out with the oil. The success attending the use of this agent, in the manner indicated, has been very gratifying to me, the only drawback being the expensive nature of the ~~agent~~ *drug*.

Acetozone is believed to be a germicide of high value, ranking with the perchloride of mercury in its destructive action on bacterial life; but, unlike the latter salt, it possesses little or no toxicity. Acetozone may be given in large quantities without causing poisonous symptoms. A strength of 5 grains to the pint [equal to a solution of 1 in 2,000] will kill the bacillus typhosus, and also the colon organism, after twenty minutes' exposure. After the administration of, say, a pint of this fluid, the symptoms begin to show signs of improvement, the restlessness disappears, the child sleeps better, loses weight less rapidly, the tongue becomes clear and moist, and the temperature gradually falls. Sometimes, in less than twelve hours, I have seen it drop from 103°F. to normal. The intestinal discharge also becomes less frequent, and the offensive odour, often associated with the stools during the first few days of the disease, soon disappears. The amount of urine secreted is increased; tympanitis and abdominal pain, if present, subside; the eyes become brighter and more prominent; stupor passes off; and the general shrunken appearance of the tissues gives place to filling in of the hollows on the cheeks and fontanelles - in a word, the whole physical and mental condition of the patient undergoes improvement, and convalescence is quickly entered upon. Once the latter is established, there is little risk of a relapse.

In the first three cases of this disease which I treat-

ed with acetozone, I was so struck with the quick improvement that I was inclined to doubt the accuracy of my diagnosis, thinking that the cases might after all be only of a dyspeptic nature. I discontinued the use of the solution, only to have a speedy return of ~~all~~ the symptoms of epidemic diarrhoea.

Some ~~may~~ ^{may} urge that it is the large quantities of fluids administered, and not the acetozone, which account for the improvement in question; but experience in the use of this agent inclines me to attribute at least some of the benefit to the administration of the drug. For I have never obtained ~~such~~ uniformly good results from the use of boiled water alone; and where I have given the acetozone in the form of powder, and boiled water afterwards in large quantities, the results were often disappointing. The explanation of this may be that, in the form of powder, the acetozone is not allowed sufficient time to undergo chemical changes ~~inside~~ inside the body, and become decomposed into benzoic acid, with the liberation of oxygen. At any rate, on account of the results, and from the fact that it is also more apt to produce irritation of the stomach, I have ceased to use it in any form save the above-mentioned dilute solution. If there is any collapse, I use a little brandy, well diluted, alone, or in conjunction with small hypodermic doses of strychnine. The hot bath is also most beneficial in these cases of collapse, especially if accompanied by suppression of urine.

The only form of nourishment I give during this stage of the disease is chicken tea, beef-juice, - either raw or in the form of Liebig's extract, - and peptonised milk.

In some cases of green diarrhoea, with acrid stools, I have found the use of an alkaline fluid better than the acetozone solution. The one I use is composed of benzoate of soda, thymol, eucalyptus, and sodium chloride, made up with glycerine, and sold under the name of ASEPSINE. About an ounce of this is added to a pint of water, previously boiled, and given in doses of half an ounce every hour. The same solution, but of double the strength, has proved most satisfactory for irrigation of the large intestine, especially in subacute or chronic cases of diarrhoea, with green stools, or in the relapses resulting from injudicious treatment of the primary attack.

Although the foregoing remarks comprise the general routine treatment which I have, from experience, found most suitable in the majority of my cases, and the one which I now always employ, - there are, however, a few other drugs,

which, from their time-honoured use in this disease, it will be necessary to briefly mention; but to describe the innumerable medicinal agents that have been vaunted from time to time, is manifestly supererogatory. Indeed, here is scarcely a substance known to pharmacologists which, at some time or other, has not been tried in cases of summer diarrhœa. The group of drugs which have received most attention within recent years are the antiseptics; and nearly every agent in this category with germicidal properties has been recommended, in the hope that intestinal decomposition and bacterial activity would be arrested by their exhibition.

SALOL.

It was thought that this drug, owing to its chemical composition, might answer the purpose in question; but, unfortunately, clinical experience has not been in conformity with laboratory experimentation.

Osborne and Grelet were the first to employ this drug. They give a very favourable account of their use of it in typhoid fever and summer diarrhœa; but it is very doubtful if the small amount of the drug given exercises any germicidal action on the contents of the bowels before it is voided in the stools, even if it is all decomposed into salicylic and carbolic acids.

If there is much gastro-intestinal disturbance, salol is not well borne. It should always be given in cachets, or suspended in tragacanth, and used in doses of 2-3 grs. every three hours for children under one year of age. Dr. Moncorvo vouches for its efficiency when thus administered.

It appears to be most useful in the treatment of the offensive stools of delicate infants fed on condensed milk or starchy foods. I have found it most serviceable in the treatment of the chronic form of this disease which we frequently see at the end of the summer. Some authorities advocate its use from the beginning, and give it mixed with castor oil; but the size of the dose required to inhibit bacterial growth at this stage of the disease, when the whole alimentary tract is loaded with decomposing food, would be so large that we would be in danger of setting up irritation of the stomach or kidneys.

SALICYLATES.

The only salicylates used in the treatment of this disease are those of sodium, and calcium.

Vaughan was the first to point out the antiseptic action of salicylic acid, in 1888; but, like salol, the results obtained by others ~~have~~ not, on the whole, been satisfactory; and most physicians prefer to administer the salicylic acid in the form of salol when they desire the antiseptic action of the former.

The salts of salicylic acid should never be used when there is any irritability of the stomach, and only in combination with bismuth, or suspended with tragacanth, - the dose being grs. ii-iii every two or three hours.

Holt, who speaks very highly of the use of salicylate of soda, advises it to be administered well diluted with food; but the fact that the salicylic compounds are decomposed in the stomach, makes one rather doubtful of their antiseptic properties. I have, ~~however~~, used a solution of 15 grs. to the pint to irrigate the colon, but the results were no better than those obtained with water alone.

The salicylate of bismuth, first brought to the notice of the profession by Escherich and Ehring, has been much used in this country in the treatment of this disease. It was formerly thought that the sedative action of the bismuth would counteract the irritating action of the salicylic acid; and, certainly, so far as my experience goes, it appears to give better results than any of the other salicylic compounds. It is best given in doses of 3-5 grs., suspended in mucilage of tragacanth, every two or three hours, until the stools become black. Like most preparations of bismuth, it exercises a marked control over the vomiting. It is thought that the salicylate of bismuth is ~~decomposed~~ ^{broken up} into bismuth nitrate and salicylic acid, the bismuth being decomposed into the oxide and nitric acid, and the latter afterwards being oxidised into nitrous acid, which is a powerful antiseptic; but, whether such changes take place under the pathological conditions occurring in diarrhœa, it is very difficult to say. But certainly this substance quickly reduces the fluid state of the stools, and diminishes the frequency of the motions in ^{of the} many cases; it sometimes also relieves pain and tenesmus.

BISMUTH.

There can be no doubt as to the value of some of the preparations of bismuth in gastro-intestinal disorders. Were it left to my option, I would rather do without opium than bismuth in the treatment of epidemic diarrhœa. Bismuth should never be used until the contents of the bowels have

been got rid of. I believe that much of the disappointment some physicians have experienced with this drug was due to their neglect of the preliminary dose of castor oil. It is quite hopeless to expect that bismuth, or any other drug, could possibly arrest putrefactive processes throughout the whole length of the alimentary tract when it is already loaded with sour undigested food refuse and mucus; if this point be borne in mind, much of the disappointment attending the too prompt use of drugs in this disease will disappear.

Personally, I prefer the oxynitrate of bismuth to any of the other salts; for it possesses greater astringent properties, and probably, owing to the liberation of nitric acid, exercises a stronger antiseptic action than the carbonate. The latter salt, however, acts better if there is much gastric irritability, due doubtless to its mechanical action on the inflamed mucous membrane; especially if it be combined with a little carbonate of soda. If the vomiting persists after the stomach has been washed out, I always begin by giving grs. x. of the nitrate every 1-2 hours, suspended in tragacanth, diminishing the frequency of the dose after the vomiting has ceased and the stools are reduced in number, when half the dose may be continued until all the symptoms have subsided. It must not be forgotten that bismuth sometimes contains sufficient quantities of arsenic to produce poisonous symptoms, and we should always, therefore, make sure that our preparation of bismuth is free from this metal.

The subgallate [dermatol] has recently come into vogue in Germany; and, owing to its astringent action, it is very useful in many cases of profuse watery diarrhoea. It may be given in doses of 4-5 grs. every two hours. I have found it of most service in the subacute or chronic forms of diarrhoea, which are apt to result from the acute epidemic type. Holt speaks highly of its use, but my experience has not been sufficiently large to give a definite opinion as to its value in this disease.

RESORCINE.

Resorcine, by virtue of its marked antiseptic properties, has long been used in the treatment of various gastrointestinal affections due to bacterial activity. I have found it useful in checking vomiting, when given in doses of $\frac{1}{8}$ - $\frac{1}{4}$ grs. every 2 hours; but its toxic properties must always be borne in mind; and, owing to its depressing effect upon the heart, it should only be given very cautiously. It is said to

aid in the reduction of temperature, but, if such an object be desirable, we have much better means of accomplishing this.

NAPHTHOL.

Although at one time in vogue as an intestinal antiseptic, this drug is now but seldom employed. Owing, however, to the difficulty attending its administration to infants, and the danger of causing vomiting and nausea, its use has been abandoned. It may be given in $\frac{1}{4}$ - $\frac{1}{2}$ gr. doses every 2 hours, in the form of B naphthol; but I have never felt justified in employing it in this disease, and cannot therefore speak of its therapeutic value.

BENZOATE OF SODA.

Benzoate of soda has been much advocated and employed largely by the German physicians, but it has not met with much favour in this country. The only advantage claimed for it is its soothing action on the stomach. It is given in doses of 1-3 grs. every three hours. I have employed the ammonium salt for cases of diarrhœa complicated with bronchial catarrh, and it seemed to do some good. It exerts a stimulating action on the skin, and may advantageously be used in cases of decomposing urine of foul odour. ^{Soda Salt} This is more useful when used in the form of a 3 per cent. solution for the irrigation of the stomach and intestines.

COAL TAR PREPARATIONS.

Various coal tar derivatives, such as CREOSOTE, CARBOLIC ACID, etc., were at one time much advocated for their well-known antiseptic properties; but the dangers attending their internal use in infants are so great as to contraindicate their employment. All powerful germicidal agents are likely to interfere with digestion when given in large doses; and, after all, it is not so much powerful intestinal antiseptics which one needs in the treatment of this disease as something to remove at once the decomposing intestinal contents, and afterwards the employment of ^{agents} ~~something~~ which will dilute or neutralise the products of bacterial action, present in the tissues or circulating in the blood.

ASTRINGENTS.

Both mineral and vegetable astringents have, in this country and Germany, been much employed in the treatment of this disease. They should only be used, however, after the first storm of attack is over, and in cases of trouble-

some diarrhœa.

The mineral astringents most used are the ACIDS, such as dilute HYDROCHLORIC ACID, which may, in doses of 2-5 m., be given every two hours after meals. It is productive of the best results in cases of dyspepsia where the tongue is coated and the thirst excessive, or where the stools contain much undigested food. I am only inclined to **order** either hydrochloric or SULPHURIC ACID, combined with nux vomica or pepsin, during the convalescent stage of the disease, in the case of infants with feeble digestion. None of these acids should be used if the infant is being fed on milk, ~~for~~ they cause coagulation of the casein. The French physicians are very fond of giving acids in large doses, but vomiting very frequently results therefrom. Sulphuric acid, in the form of the aromatic preparation, is sometimes useful in cases of dysenteric diarrhœa with blood in the stools, a useful prescription for this purpose, especially if there is much pain, the following:

R.

Acid. sulphur. aromat. m. iii.
Liquor. morph. sulph. m. ii.
Tinct. kramer. m. v.
Syrup. simp. ad 3i.

Pollock employs no other drug in this disease except sulphuric acid, and he gives it in large doses.

LACTIC ACID.

This is one of the vegetable acids, which was formerly much used in France in the treatment of this disease; but, owing to our extended knowledge of the pathology of the affection, it has now fallen into disuse. The French physicians used to administer it in the form of a 2 per cent. solution, of which thirty minims were given every half to two hours after food. Professor Hayem considers it valuable in cases with green stools; he recommends that it be used five or six times daily in large doses, when the stools, he says, will soon return to their normal colour. I have had great trouble in giving even twelve minims of the above mentioned solution, and the results were so disappointing that I gave up its exhibition entirely in cases of infantile diarrhœa.

ACETIC ACID.

Equally disappointing have been my results from the administration of acetic acid, which has found favour

with many for the treatment of cholera infantum.

SILVER NITRATE.

The nitrate of silver has been long employed, especially in the chronic forms of intestinal catarrh with diarrhœa. It is used either as an enema, for the irrigation of the colon, or by the mouth, ^{mixed with} ~~in~~ sugar or acacia powder. I have found it of great value when given by the bowel after irrigation. I employ about 1 gr. to each ounce of water; and as much as six ounces of the solution may be used, every four hours, if the diarrhœa is profuse; or we may give one enema of silver nitrate solution, followed by an opium and starch injection, especially if there is much irritability of the bowel or pain. Intestinal irrigation may be combined with the administration of the drug by the mouth.

Pepper speaks very highly of this combination in chronic diarrhœa, and Trousseau and Pidoux of its internal use in the chronic diarrhœa associated with dentition. Hirsch also is just as warm an advocate of it in similar cases, when given in doses of one-fortieth of a grain, made up with gum acacia and sugar, every two hours. Dr. Eberb has used it extensively in both subacute and chronic cases of enterocolitis, and says that he has "never known the slightest inconvenience to result from its use when administered in a mucilaginous solution and in very small doses".

The drug should always be given well diluted some time after food; and, if we find it rejected when given by the bowel, it is well to both reduce the size of the enema and dilute ~~its~~ strength, and then add a drop or two of laudanum. I have treated four cases of subacute enterocolitis by silver nitrate, and never found any bad effects resulting; still, it is a drug which requires to be given with care and to be carefully watched, and should not be continued for more than two or three days without intermitting its exhibition. As a rule, the effects which follow its administration by the mouth are more lasting, but not so quickly brought about as when it is given by the rectum.

At various times COPPER SULPHATE, ZINC SULPHATE, and LEAD ACETATE have been employed. Dr. Goodeve speaks highly of the lead salt in doses of $\frac{1}{4}$ - $\frac{1}{2}$ gr., every two or three hours.

VACCINIUM MYRTILLUS.

The common bilberry has been much used, in the form

of the juice, both in this disease and in typhoid fever. Henoch speaks highly of it in the diarrhœa of older children. According to him, this "very old and popular remedy has done me good service and that speedily in cases which although perhaps not severe enough to cause anxiety had yet resisted the action of many other drugs and children are very fond of it. I have seen black motions of a firm consistency from its use even within twenty-four hours, and recovery taking place without any other remedy."

Dr. Bernstein has recently drawn attention to its anti-fermentative and germicidal action, in a lecture delivered to the Hunberian Society. He regards it as very useful in the treatment of putrefactive processes of the alim^mentary tract.

In many parts of the North of Ireland, where the bilberry grows wild, I have seen it used as a favourite remedy for diarrhœa.

The juice contains malic and lemonic acids, as well as some tannin.

Amongst the other vegetable astringents one might mention GALLIC and TANNIC ACIDS, and their SALTS.

Dr. Tansey has recently called attention to TANNIGEN. It appears to possess some value in the treatment of the chronic forms of infantile diarrhœa, and does not interfere with digestion to the same extent as the other tannin compounds.

Other vegetable astringents containing tannic acid, - such as CATECHU, RHATANY, KINO, LOGWOOD, and HAMAMELIS, - have been employed, and many of them still find a place in the armamentarium of the older practitioners. They are, however, gradually disappearing, as we become more familiar with the morbid changes underlying this disease, and the part played by bacteria in the production of toxic symptoms. I have sometimes used the compound catechu powder (containing catechu, kino, krameria, and aromatics), and found it very useful in the diarrhœa of children and adults. Dr. E. Smith speaks highly of hæmatoxylin in the treatment of the summer diarrhœa of infants, but it appears to possess no advantage over the other tannin compounds.

COTO, introduced as a specific for the treatment of this disease by v. Guk, of Hamburg, has now fallen into disuse.

All the other vegetable astringents are very apt to upset the digestion; and are only useful in cases which have lapsed into a state of entero-colitis or chronic intestinal catarrh; which, again, are much better treated by intestinal

irrigation and silver nitrate.

Before closing the subject of treatment, a brief reference to the use of GELATINE, as employed by Lumière and Péhu, may be made. They give the infants pure gelatine, previously sterilised, mixed with their food. At first a grain of gelatine was given with each meal, and the amount was gradually increased until the infant was getting as much as 2 drs., six or eight times a day; this was continued until the stools were normal, which, as a rule, resulted in about three or four days. It would appear to give the best results in cases of simple localised enteritis with vomiting, and has no influence on the other symptoms of the disease.

STIMULANTS.

These are indicated in the stage of collapse which frequently results from the pyrexia and the loss of the fluids of the body.

Reference has already been made to the use of the warm bath, the application of mustard to the chest and abdomen, and the giving of warm solutions per rectum, to which a little ether or brandy may be added. We have also seen that the subcutaneous injection of warm saline solution, into the cellular tissues, possesses wonderfully stimulating properties during the stage of collapse; and, when combined with the hypodermic use of strychnine, is of considerable benefit in many of the cases attended by heart failure, in which, ~~again~~, brandy ^{maybe} is inadmissible.

Brandy should never be given in cases where there is much vomiting. It should be well diluted with iced water or champagne, and employed in doses of 15-20 m. every hour, for from twelve to twenty-four hours, when it is well - tentatively at least - to discontinue its use. Sometimes when brandy disagrees or causes delirium, whisky - in the form of old pot still - may be employed. As a rule, I have obtained better results from the administration of spirits in this form, - for the reason that brandy is apt to clog the nerve centres and cause vomiting and gastro-intestinal irritation, which may become chronic, or the case pass into the encephaloid form.

TREATMENT DURING CONVALESCENCE.

The greatest care should be exercised over the case at this stage. Milk must only be given in very small quantities, and well diluted with lime or barley water, and a little citrate of soda added to each feed; peptonised milk may be used, - but, as already pointed out, it must be used with care. There ought to be no relaxation of the hygienic management ~~of~~ the ventilation of the infant's room; and cleanliness of the person should be as strictly observed as during the acute stage. The patient ought to be kept in bed, or confined to the room, until the temperature returns to normal, and, ^{until} there is, for two days at least, complete cessation of the vomiting and the diarrhoea. Beef-juice, chicken or veal broth may be given, two or three times daily, in addition to the sterilised milk; and, if there is any tendency to relapse or if the digestive powers are feeble, a little sherry or port may be administered.

The first opportunity should be seized of removing the infant to the country or seaside; for the beneficial effects of a change of air, during this stage of the illness, cannot be overestimated. Those whose circumstances will not permit of this, should be encouraged to wheel their infants out in the parks and gardens, or to make short excursions into the country.

When the convalescence is somewhat protracted and the child not putting on flesh, Parrish's syrup may be ordered; or, if the infant shows signs of rickets, lacto-phosphate of lime may be prescribed.

I have now for three years been employing, in cases of relapse ~~and~~ ^{with} malnutrition, an emulsion of petroleum with the hypophosphites of lime and soda, and with the most gratifying results; it has been my routine practice to order this emulsion in all cases of the disease after convalescence has been definitely established. I find that, instead of disagreeing with or retarding digestion, it actually promotes it; and infants under 2 years of age take it well in doses of $\frac{1}{2}$ - 1 drachm, three times a day ~~exhibited~~. It appears to diminish flatulence, keeps the stools healthy, and protects against constipation - sometimes in itself a troublesome matter to deal with, owing to the diminution of the hepatic and intestinal secretions and atony of the colon. It is of very special value in cases complicated with broncho-pneumonia.

Dr. Fothergill, of Manchester, has treated 100 cases of all forms of summer diarrhœa with this preparation alone, and speaks in high terms of its use during the acute stage of the illness. "In a large number of cases," he says, "recovery occurred rapidly and completely without any treatment beyond the administration of petroleum ~~and~~ emulsion, no derangement of the stomach was noticed in the cases so treated, the vomiting ceasing, as a rule, before the diarrhœa was checked. The motions began to be less frequent after two or three doses and rapidly resumed their normal smell, colour, and consistence. It was further obvious that the treatment in a large proportion of the cases in some way favoured recovery from the bronchial catarrh which accompanied the diarrhœa."

Petroleum emulsion offers an excellent vehicle for intestinal medication, being itself soothing and demulcent to the intestinal mucous membrane. It, moreover, contains nothing that will support bacterial life; but, on the contrary, - according to Dr. Burbridge White, of Dublin, - it is capable of inhibiting the growth of putrefactive micro-organisms, and can also check alcoholic, lactic, and butyric fermentations.

This is an agent which I think should receive further trial, especially in the acute stages of the disease. I have used it in eleven cases of the affection from the beginning of the illness, but only as a vehicle. I intend, however, at some future time to employ it alone, after the contents of the stomach and intestines have been got rid of.

F I N I S.

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Creighton H. Lindsay.

February 14th, 1906.

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